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JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ALBERT FREDERICK HILL
RALPH CARLETON BEAN
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RADCLIFFE BARNES PIKE
LORIN IVES NEVLING, JR.
ELIZABETH ANNE SHAW
} Associate Editors

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WESTERN CAPE COD: PLANT NOTES

HENRY K. SVENSON

I am not a stranger to Cape Cod. My father came to visit the Cape first about 1885, and from then on made frequent trips from Boston by train in the summers. Therefore as a small child I remember seeing, in many visits, lupine and the Deptford pink in the lichen-covered fields at East Sandwich, which were then fairly open. They are now grown up into pitch pine, and everywhere pastures and hayfields have practically disappeared. The forest has greatly increased, due also to the lessening of forest fires, and now appears mainly as an expanse of oak and pitch pine occupying the terminal moraine, the backbone of the Cape. From 1917 on, the botanical trips led by Professor Fernald to the Cape were always enjoyable and instructive occasions. Summers from 1923 to 1926, while at the Marine Biological Laboratory at Woods Hole, Dr. John M. Fogg, Jr. and I made many botanical trips into the surrounding countryside; and again in 1928, Professor Fernald and I explored some of the relatively little-known parts of western Cape Cod.

Many things have changed. Some of the old roads are now blocked off, and I have been unable to locate the *Chamaecyparis* swamp in East Falmouth where we found *Rhododendron canadense* and *Aster nemoralis*. And I cannot find the interesting spot reported by me in Rhodora 30: 135 (1928), where *Lycopodium lucidulum*, *L. clavatum*, and

associated plants grew. Some of these places I suspect have been covered up by the Otis Air Field.

Since retiring to Cape Cod in early 1967, I have covered most of the old roads in western Cape Cod, to a large extent on foot, since many are no longer passable by automobile. The result is a fairly large number of plants scarce or previously unknown on Cape Cod. Those of which I can find no previous records from literature or from the extensive collections of the New England Botanical Club, I have marked by an asterisk. Specimens have been put in the herbarium of the New England Botanical Club.

In 1918 and 1919 Professor Fernald and Bayard Long found an interesting locality for plants at "Spring Hill", Sandwich. After a considerable search I found the locality, which is in East Sandwich. The beautiful maple and *Chamaecyparis* swamp is still intact. The sloping pastures have disappeared, and in many places have been replaced by a fearful tangle of *Smilax* (*S. rotundifolia* and *S. glauca*), called "catbrier" in Gray's Manual, but known more appropriately by the local inhabitants as "bullbrier" and "horsebrier". Intact also are the stands of yellow birch *(Betula lutea)*, the spring-heads still have *Carex scabrata*, and on an adjacent knoll is native *Fraxinus americana*, as Fernald found it, along with *Carex laxiflora*, *Carex laxiculmis*, and *C. convulata*, as well as *Ranunculus abortivus* and *R. recurvatus*; and in 1967 there was a single flower of *Erigeron pulchellus*, which Professor Fernald's keen eye had recognized fifty years ago on the basis of only a single leaf. The small species of *Botrychium (B. matricariaefolium* and *B. lanceolatum)* I could not find; neither was there any trace of *Ophioglossum*, or of the silvery spleenwort, or of *Trillium* in flower. The presence of this little knoll with its fragment of rich wood's vegetation is hard to explain.

Scattered along the moist north slope of the terminal moraine, and at the margins of some ponds in the interior are small "forests" of beech, hornbeam *(Ostrya virginiana)*, sweet birch, paper birch, flowering dogwood, hickories *(Carya glabra*, *C. ovalis*, and *C. tomentosa)*, white

pine, and red oak. There is much resemblance to the flora of the northern part of Long Island, New York, where these species are also present. Likewise there is a single locality for hemlock. But the relative lack of mountain laurel on Cape Cod is a noteworthy difference.

Most of the ponds on Cape Cod, even the little ones, are in the process of becoming "lakes" bordered by house lots. Some of the names have changed from those on the old maps: Great or Nine-mile Pond in Barnstable (Centreville) is now Lake Wequaquet; Halfway Pond in Barnstable (Hyannis) is now Mary Dunn Pond. The political divisions are confusing, too. All the Cape belongs to Barnstable County. The village of Barnstable is on the north shore. The Town of Barnstable includes the villages of Hyannis (now a metropolis), Centreville, Osterville, Cotuit, Marstons Mills, and Santuit. Western Cape Cod, commonly known as the "Upper Cape", includes the separate towns of Barnstable, Sandwich, Mashpee, Falmouth (with Woods Hole and Waquoit), and Bourne (with Sagamore and Pocasset).

Isoetes Tuckermani A. Br. Lovell's Pond, Santuit (no. 1468). This is the common quillwort of Cape Cod ponds; it grows submerged in several feet of water. The megaspores average 520 μ, with a fragile jagged-crested honeycomb surface. It has been collected previously in Sandwich, Falmouth, Harwich, Brewster, and Wellfleet.

Ophioglossum vulgatum L. var. *pseudopodum* (Blake) Farwell. Thicket along east side of Santuit River, Cotuit (no. 811). The adder's-tongue fern has been known from Sandwich, Yarmouth, Dennis, Chatham, and Truro.

Osmunda Claytoniana L. Thicket along Sandwich-Cotuit Road near Wakeby Pond, Sandwich (no. 1483); along railroad near County Road, East Sandwich (no. 2046). I have seen it also along Discovery Hill Road in East Sandwich. In the New England Botanical Club Herbarium it is represented from Falmouth; from near Peter's Pond in Mashpee; and from the border of the maple swamp at "Spring Hill,

Sandwich". It occurs only on "Upper" or western Cape Cod (See Fogg, Rhodora 32: 176 (1930).

Botrychium virginianum (L.) Sw. A single plant (fruiting) on a hummock beneath *Chamaecyparis*, growing with marsh fern, goldenrod, and *Mikania* at the edge of a brackish marsh (no. 661). This is a most unusual habitat for the rattlesnake fern, which would be hidden in a tangle of *Mikania* later in the season; it is known from Cape Cod only on the basis of a leaf fragment collected by Fernald and Long at "Spring Hill" in 1918.

Polypodium virginianun L. The polypody fern grows on several north-facing gravel banks on Cape Cod, just as it does on the coastal plain around Chesapeake Bay in Maryland. Usually I have found it on Cape Cod in groves of *Ostrya* where the ground slopes steeply to a pond, for example, the western side of Mashpee Pond where it is abundant in several large patches (no. 1798); Peters Pond, in South Sandwich (no. 1709); Lovell's Pond, Santuit. It is known from Bourne, Barnstable, Sandwich (near Wakeby Pond), Brewster, and Providence. In Brewster it was noted on a stone wall by Hunnewell and Blake, and on a large boulder in Naushon by Fogg, Rhodora 32: 227 (1930). The European *P. vulgare* I saw growing on gravel banks facing the sea near Cuxhaven, Germany, in 1958.

Polystichum acrostichoides (Michx.) Schott. The Christmas fern, rare on Cape Cod, is limited by Fogg (l.c) to the Upper Cape, and known only from Barnstable Village, South Sandwich, and "Spring Hill". It also grows near Discovery Hill Road in East Sandwich (no. 668), and I have seen a single large plant in woods near Amos Pond in Mashpee.

**Juniperus communis* (L.) var. *depressa* Pursh, was reported from the north shore of Naushon by Fogg, where possibly introduced. It is apparently native in a sandy field on the east side of Wequaquet Lake, Centreville (no. 1325), and on a sandy roadside in West Barnstable (no. 1959), along route 6. The nearest mainland location for this plant

seems to be near the old Darby railroad station in Plymouth, where it was collected by Sanford in 1911.

**Tsuga canadensis* (L.) Carr. About twenty trees on a steep bank of an island in Mystic Pond, Marstons Mills (no. 1086). The trees are considered native by all the local inhabitants; there is no reason to believe otherwise. Some are two feet or more in diameter; several have had the tops blown off in recent hurricanes, and are branched from the lower part of the trunk. The nearest stands of hemlock appear to be at the Plympton-Kingston line in Plymouth County. A single large weatherbeaten tree may be seen along rte. 3, opposite Bloody Pond in southern Plymouth, about halfway between the Cape Cod and Kingston localities.

**Panicum amarum* Ell. Margin of sand dunes, marsh side, Sandy Neck, W. Barnstable (no. 1730). Only two clumps were seen; one greenish-flowered, the other purplish. They grew side by side. The plant is unknown north of New Haven, Conn. It is readily distinguished from *Panicum virgatum* by the decumbent habit, narrow inflorescense, and large spikelets, in this collection 6.0 mm long. The fresh anthers are lucid brown, glutinous, and 2.4-2.5 mm long in the purplish phase; 0.8-1.1 mm long in the green phase.

Panicum mattamuskeetense Ashe. It is a tall plant of the southern coastal plain which reaches its northern limit on Cape Cod, where it has been known from Falmouth, Dennis, Brewster and Harwich. It was abundant on damp sandy cart roads in West Yarmouth just over the Hyannis line (no. 1508), the leaves bluish-green when fresh; spikelets 2.3 × 1.1-1.2 mm, and the ligule 1-1.5 mm, though stated by Hitchcock to be 0.7 mm long, by Gleason 1 mm or more long, and by Fernald "less than 1 mm long." In a second locality, a sphagnous depression just north of rte 28 in Centreville (no. 1684), the spikelets were 2.0-2.1 mm long and 1.0 mm wide, and the ligule 0.5 mm long; evidently a small-fruited phase of *P. mattamuskeetense*, though in some respects the habit approached *P. spretum*. A third

collection (no. 1432), from plants abundant in the extensive boggy area, now being drained, west of Higgins-Crowell Road, West Yarmouth (and a continuation of the locality from which no. 1508 was obtained), the upper as well as the lower leaves are somewhat pubescent, and the plants approach *P. annulum* Ashe, which is considered by Fernald as perhaps not distinct from *P. mattamuskeetense*. The spikelets in no. 1432 are 2.5-3.0 mm long, the ligules are mainly 0.5-0.6 mm long, but may be as much as 1 mm long in the lower leaves. Typical *P. annulum*, with somewhat velvety leaves and large spikelets is known from only a single collection on Cape Cod: cranberry-bog roads east of Slough Road, Harwich, Fernald in 1918. My fourth collection (no. 1464; Aug. 1, 1968) came from the gravelly bed of a brook in Marstons Mills, where it was growing with *Xyris torta* and *X. caroliniana*. It had the erect growth of *P. mattamuskeetense*, pubescent spikelets averaging 1.7 × 1.0 mm and ligules 0.5-0.6 mm long. The small spikelets would tend to place the collection in *P. microcarpum* Muhl., but the spikelets of that species are described as "glabrous or rarely minutely pubescent" by Hitchcock & Chase; and in the 8th edition of the Manual as "glabrous (very rarely puberulent), 1.5-1.8 mm long, 0.7 mm broad". *Panicum microcarpum*, in which the autumnal form is "densely and intricately branched", is known from five collections on the Cape, ranging from Woods Hole to Orleans. I have seen it in Sandwich and Centreville, growing on moist grassy slopes. By Fogg, Rhodora **32**: 211 (1930) it is considered characteristic of the "Middle Cape". The members of this *Panicum*-group are still puzzling.

Festuca obtusa Biehler. This grass is frequent in moist rich woods in the Boston district, but known only from Sandwich and Chilmark (Marthas Vineyard) in the southeast. In Sandwich it grows on a north-facing slope at Shawme Pond. It is now to be reported from the beech woods at the Cape Cod Museum of Natural History, Brewster (no. 2146).

**Molinia caerulea* (L.) Moench. In the report on grasses of the Flora of Massachusetts, Rhodora 49: 264 (1947), the "moor-grass" is reported only from waste land in South Boston. This handsome grass is growing well, and apparently spreading, on a sandy border of Forestdale Road in Mashpee (no. 1262; Nov. 1, 1967). It is common in Scotland, but I have seen it in this country only at Scott Center, Wayne Co., in northeastern Pennsylvania, in company with Mr. W. L. Dix (*Bartonia* 23: 41-42. 1945). There it occupied nearly an acre on a dry hillside.[1]

**Aira praecox* L. Abundant on roadsides and in newly planted areas in Osterville (no. 711), forming a sort of turf in moist ground and reaching a height of 20 cm. It is also abundant along rte 28 in Mashpee and Santuit (no. 698). Previously *Aira praecox* has not been reported north of New Jersey, except from Nantucket in the recently published "Plants of Nantucket" by MacKeever, (1968). It commonly grows with *Aira caryophyllea*, which is also a native of Europe.

**Sporobolus cryptandrus* (Torr.) Gray. Abundant in a sandy field at the south end of Hamblins Pond, Marstons Mills (no. 1139). The spikelets are 1.9 mm long. It has previously been known from "sandy and gravelly soil; occasional in the Boston District chiefly near the seacoast, and at Scituate in Plymouth County", Rhodora 49: 273 (1947).

**Carex convoluta* Mackenzie. Open woods at edge of swamp at "Spring Hill", East Sandwich. The leaves reach 2 mm in width; culms are erect; perigynia are 3.0-3.5 mm × 1.5-1.7 mm; the achenes, excluding the tips, average 1.9 × 1.4 mm. Mr. Mackenzie told me that he could distinguish the three closely-related species (*C. convoluta*, *C.*

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[1]Dr. Hodgdon has asked me to include here a collection of *Molinia* made by David Wise and himself (no. 552) in September, 1959, on Isle au Haut, Maine. It covers a considerable area where it has persisted since it was first found there by Nathanial T. Kidder in 1919. I might also mention that the "moor grass" appeared, along with heather and an *Erica* in the artificial bog at the Brooklyn Botanical Garden in the 1930's. They came from seeds in baled European peat-moss.

rosea, and *C. radiata)* in the field as far as he could see them, and I tend to agree with him. Measurements in the herbarium tend to overlap, and the natural appearance of the plant is commonly lost on the herbarium sheet. *C. convoluta* is common in woodlands of the Boston area, and runs southward into Dighton and Fall River in Bristol County. Another and earlier collection (no. 730) from the Cape Cod locality (June 13, 1967) is not quite mature; the perigynia average 3.0 × 1.0-1.5 mm.

**Carex vestita* Willd. Sandy margin of a cranberry bog, southeast of Amos Pond in Mashpee (no. 699), and close to, or on, the Sandwich line. The staminate spikes of the species are especially prominent. The plant is common around Boston, and is known from Scituate and Wareham in Plymouth County.

**Carex prairea* Dewey. Abundant in large tufts in fresh to brackish border of Bumps R., Osterville (no. 717). It is known from a few localities in northeastern Massachusetts, especially in the vicinity of Concord, but not from southeastern Massachusetts except on Nantucket, where it was collected by Bicknell.

**Carex exilis* Dewey. Dry opening in a little *Chamaecyparis* swamp, near the headwaters of Scorton Creek, East Sandwich (no. 679; June 4, 1967). A single fruiting plant was seen on Aug. 17, 1967 (no. 1049); in the wet summer of 1968, fruiting plants were more abundant.

**Carex Crawfordii* Fernald. A single large clump in gravel excavations along rte 6A in Sagamore (no. 1369), very close to the Sandwich line. In southeastern Massachusetts it has been known only from Harwich, where it was collected by Fernald and Long on June 25, 1918, and noted as "scarce, in dry sandy fields and borders of woods". *C. Crawfordii* is a common plant in the White Mountains, and in other parts of northern New England.

Carex scabrata Schwein. Spring-heads at margin of swamp along rte 6A, West Barnstable (no. 2003) in proximity to *Dryopteris Phegopteris* and *Luzula multiflora* var. *fusconigra*, plants likewise characteristic of northern New England. *C. scabrata*, which frequents woodland brooks,

extends south commonly to the Boston area. In southeastern Massachusetts it is known only from "Spring Hill", in East Sandwich.

**Carex laxiflora* Lam. Wooded knoll at edge of swamp, East Sandwich (no. 727; June 13, 1967, and no. 1991; May 25, 1968). This is the same location as "wooded springheads bordering maple swamp", *Fernald & Long* 18415, July 30, 1919, determined by Fernald as *C. leptonervia* (likewise by Wiegand in 1922); and "rich wooded slope", *Fernald & Long* 18416, Aug. 9, 1919, determined by Fernald as *C. laxiflora* var. *blanda*, and in 1922 by Wiegand as *C. leptonervia*. Both of their collections were made late in the season. The perigynia are poorly developed and show only slight nervation, which is not produced into ribs. Vegetatively they are similar to my collections which are in a fine stage of development. *C. leptonervia*, therefore, can surely be deleted from the Cape Cod flora. *C. laxiflora* is common in the Boston region, and it extends south to North Easton and Rehoboth; it is not known from Plymouth County. *C. leptonervia* extends south to the Blue Hills near Boston, and also to Attleboro in Bristol County. Both species are listed from Stoughton (Norfolk County) by S. F. Blake in The Flora of Stoughton, Mass., published by the New England Botanical Club, 1963.

**Eleocharis tuberculosa* Michx. In sand and peat at margin of a cranberry bog, growing with *Rhynchospora capitellata*, East Sandwich (no. 1065). It is known from Plymouth County, and is of wide distribution on the coastal plain.

Lemna minor L. Specimens are recorded only from Barnstable, Brewster, Harwich, Eastham, Wellfleet, and Provincetown, but this little floating plant is probably of more general occurrence. Few people have seen *Lemna* in fruit. Fruiting collections were made by me at Santuit R., at head of tide (no. 1467; July 22, 1968), and in a small dried-out *Cephalanthus* swamp south of Hamblins Pond, Marstons Mills (no. 1190; Oct. 12, 1967). The utricles vary from glaucous purple to green, of a color similar to the spathes of skunk cabbage, they are obovate and strongly

flattened, 1 mm wide and 1 mm high. The seed lies crosswise in the utricle and is nearly terete, 0.8 × 0.5 mm in no. 1476; 0.7 × 0.4 mm in 1190. It is greenish-white, somewhat corky-inflated, strongly ribbed, obscurely cellular-reticulate, and sometimes with faint crossbars between the ribs. There is a prominent crimson-to-brown caruncle, but the operculum is inconspicuous.

In *Lemna perpusilla* the seed is also large, commonly 0.9 × 0.5 to 1.0 × 0.4 mm; it is loosely erect within the utricle, which is elliptic. In a collection made by Torrey on Staten Island, N.Y., in 1829 (Gray Herbarium), the utricles are about 0.75 × 0.5 mm, and the style varies from erect to oblique; I did not attempt to measure the seed. Plants which I collected in the Galápagos Islands and the coast of Ecuador under the name *Lemna minor* Philippi have been relegated to *H. perpusilla* by E. H. Daubs, Univ. Illinois Mon. no. 34. 1965, but the seeds are small, only 0.35-0.4 × 0.2 mm. They are erect, terete, longitudinally ribbed with conspicuous cross partitions and completely fill the utricles. Their size and configuration is not at all that of *L. perpusilla*. Clearly more taxonomic work on the utricles and seeds of *Lemna* is needed.

Lemna valdiviana Phil. Forming small tangled submerged clumps, as is usual in the species, in a pond at Discovery Hill Road, East Sandwich (no. 1703). It has been known from Woods Hole and Hyannis.

Spirodela polyrhiza (L.) Schleiden. Pond at Discovery Hill Road, East Sandwich (no. 1703A). It has been known previously from Falmouth (see Fogg, Rhodora **32:** 106 (1930), and in 1938 from Marstons Mills *(Seymour)*.

**Luzula multiflora* (Retz.) Lejeune var. *fusconigra* Celak. Mossy hummock beneath large beech tree, at edge of a swamp along rte 6A, West Barnstable (no. 1999). The leaves are narrow, mostly less than 2 mm wide, the inflorescence tends to be congested, and the perianth is deep brown, almost black. It is known from eastern Canada, and southward definitely to Old Orchard, Maine.

Trillium cernuum L. Nearly a hundred plants in flower May 31, 1967, excavation in wooded slope, East Sandwich (no. 656). Previously it has been known from "Spring Hill" (see introduction).

Goodyera pubescens (Willd.) R. Br. Depression in *Cornus florida* "forest", east of Johns Pond, Mashpee (no. 2008). The only previous Cape Cod record is from Jenkins Pond, Falmouth, in 1911 and 1912.

Spiranthes Grayi Ames. Sandy field, Osterville (no. 1062). This little orchid has been known from Pocasset, Falmouth, Centreville, Brewster, Harwich, Eastham, and Truro.

Betula lenta L. Abundant large trees (one foot or more in diameter) in woodland, east side of Wakeby Pond, Sandwich (no. 1179). The sweet or cherry birch, known locally as "red birch", forms extensive stands also in the Lowell Holly Reservation in Mashpee, just to the southward. In a mimeographed list of plants compiled for the Lowell Holly Reservation in 1961 by Stephen Hamblin — whom many of us will remember at the Harvard Botanic Garden — *Betula lenta* is listed as a native tree. Mr. Hamblin retired to Santuit and wrote up the account for President Lowell. After Mr. Hamblin's death in 1966, the list was given to the Cape Cod Museum of Natural History at Brewster. The birch grows also on the opposite shore of Mashpee Pond at the narrows. The nearest localities for *Betula lenta* appear to be at the Plympton-Kingston boundary in Plymouth County. As Mr. Hamblin states, the Reservation "represents the native vegetation of upper Cape Cod, undisturbed by fire or cutting for at least two or three hundred years".

Betula lutea Michx. A single tree, the five trunks each about 8 inches in diameter at border of pond, Discovery Hill Road, East Sandwich (no. 674). This locality, west of the previously mentioned locality at "Spring Hill", appears to be the only additional Cape Cod occurrence of the yellow birch, except at Shawme Lake, Sandwich, mentioned by me in Rhodora **31:** 80 (1929). John Hay, President of the Cape Cod Museum of Natural History, and I were un-

able to find the yellow birch mentioned by Mr. Hamblin in the Lowell Holly Reservation list, but we did find several trees of paper birch, omitted from the list.

Betula papyrifera Marsh. There is only one Cape Cod specimen of the paper birch in the Herbarium of the New England Botanical Club. It is from the "rich wooded slope at Spring Hill, *Fernald & Long*, Aug. 9, 1919." But it is more widespread. Trees have been planted along the main highway, rte 6, but native trees are scattered in many places. The finest trees are to be found on the north-facing moraine slope east of Atkins Road in East Sandwich, where they have been carefully preserved in land clearing. They are a little over 1 ft. in diameter. The greatest assemblage of trees appears to be at the north end of Santuit Pond in Mashpee. I have also seen a tree at the south side of Lovell's Pond, Santuit (no. 1890), another in Osterville, and scattered trees in Falmouth. Most of the trees have the appearance of those on Long Island, New York, where they occur on the terminal moraine at Wyandanch.

Castanea dentata (Marshall) Bork. Two clumps, each about 10 ft. high, vigorous though half-blighted, Old Jail Road, West Barnstable (no. 1763; Sept. 10 1968). The only specimens at the N.E.B.C. are from Yarmouthport (1907), and Bourne (1918). According to reports of older inhabitants the chestnut was only occasional on Cape Cod.

Quercus rubra L. Large tree on sandspit between Middle and Mystic Ponds, Marstons Mills (no. 1961; Jan. 27, 1968). Around these ponds is probably the largest assemblage of red oaks on Cape Cod. The best time to see them is when the ponds are frozen. While ice-fishing I counted over twenty trees on the above date. There are probably many more; the trees can be most easily recognized by the large flat cups on the ground. Large tree overhanging the water, Mashpee Pond, Mashpee (no. 1180). Mr. Hay and I counted nine trees in the adjacent Lowell Holly Reservation, where the red oak was not mentioned by Mr. Hamblin. There is also a group of red oaks at Discovery Road in East Sandwich, the largest 33 inches in diameter. The red oak is

otherwise known on Cape Cod (specimens in the N.E.B.C.) only from Wellfleet, and from Cliff Pond and No Bottom Pond, both in Brewster.

Ceratophyllum demersum L. Fruiting plants in ditch in cranberry bog, East Sandwich (no. 1068). Previously it has been collected in Chatham and Eastham. Fruiting material, rarely seen, was obtained by Fogg at Oyster Pond, Falmouth (Rhodora **32**: 107 (1930)).

Thalictrum revolutum DC. Roadside, near Cotuit R., Mashpee (no. 794). It is one of the plants characteristic of the Upper Cape (Fogg, Rhodora **32**: 176 (1930)), previously known from Woods Hole, Falmouth, Sandwich, and Centreville.

Nasturtium officinale R. Br. There are no specimens from Cape Cod, but the plant is abundant in several streams, including Mashpee R., Mashpee (no. 705) ; Santuit R., Cotuit (no. 805) ; and Herring Brook, North Falmouth (no. 2072). The siliques of 2070 (June 8, 1968) are rather small, averaging 8 × 2 mm; the style 0.8 × 0.4 mm. The other collections were only in flower.

Ribes hirtellum Michx. var. *calcicola* Fernald. Tidal banks of Marstons Mills R., Marstons Mills (no. 1451; July 29, 1969), in fruit. The fruits are smooth, red and glaucous, 1 cm wide when flattened. Seeds, apparently not previously described, are lucid brown, somewhat flattened, irregularly ovate, and 4-5 × 1.5 mm. They are surrounded by an adherent gelatinous substance. Var. *calcicola* was described from calcareous swamps of Gaspé, Quebec, with "young branches, petioles, and lower leaf-surfaces permanently and densely white tomentose". Many collections from Cape Cod have been so named, but whether they exactly represent var. *calcicola* is open to question. Petioles in no. 1451 are pubescent, but the leaves are only hirtellous on the veins beneath. The plant is to be expected in thickets at the head of tidal streams throughout Cape Cod.

**Crataegus monogyna* Jacq. The European hawthorn has not been reported from Cape Cod, but small trees are abundant along the railroad east and west of West Barnstable

station, altogether for at least a mile (no. 744, in flower June 11, 1967; in fruit, July 30, 1968).

Corema Conradii Torr. Open hilltops under pitch pines north of DeGrass Road, South Mashpee (no. 1096). It is also known from North Falmouth, Osterville, Dennis, and West Brewster, but mostly it has been associated with the open sands extending from Eastham to Provincetown. In the middle and western part of the Cape it forms a springy carpet beneath pitch pines. Consequently there is no reason to question its being native in the Lowell Holly Reservation, where it was reported by Mr. Hamblin, and where it has been known for a long time. My first acquaintance with *Corema* was in the sands of Wellfleet and in similar situations in the New Jersey Pine Barrens, where Witmer Stone (Rept. N.J. State Museum, 1910) says it is "an inhabitant of those desolate stretches of white sand which cover the most elevated portion of the Pine Barren region, stretching away for some thirty square miles." As I have seen the plant on the Maine coast in hills north of Camden, and on the promontory known as "Gertrude's Nose", in the Shawangunk Mts. of southern New York, it does not grow in sand. It is listed in Gray's Manual, ed. 8, from "sandy pine-barrens, sandhills and siliceous rocks".

**Rhamnus frangula* L. Tree about 15 ft. high, in swamp along railroad, East Sandwich (no. 1198; Oct. 17, 1967, in fruit). Hodgdon and Krochmal (Rhodora 52: 163 (1950)), discuss the presence and spread of this species in New Hampshire.

Circaea quadrisulcata (Maxim.) Franch. & Sav., var. *canadensis* (L.) Hara. Moist woods along Marston Mills R., below rte 28, Marstons Mills (no. 1452). It has been found previously in Bourne, Falmouth, Sandwich, and Brewster.

Rhododendron canadense (L.) Torr. Rhodora in flower, June 2, 1967, occurring over nearly an acre southeast of Johns Pond (no. 664). The area is now bisected by a power line, which may help in preservation.

Kalmia latifolia L. Bushes to 6 ft. high, abundant on steep slopes at east side of Long Pond, Newtown, Barn-

stable (no. 655). The mountain laurel has not been reported previously from Cape Cod, but Miss Eda M. Roos of East Sandwich informs me that it has been known as a native plant for more than a half century near the north end of Wakeby Pond, which is close by. It is surprising that this bush, so abundant on Long Island, should be of such limited occurrence on Cape Cod.

Gentiana crinita Froel. The fringed gentian, as in most other places, tends to be sporadic in occurrence. It has been known for a long time at East Sandwich, sometimes in profusion, at other times scarce. I collected it on Nov. 9, 1966. For the past two years it has not made an appearance, but will probably do so when conditions for growth are favorable. It is known from several localities in Plymouth County.

Bartonia paniculata (Michx.) Muhl. *Chamaecyparis* swamp, South Main St., Centreville (no. 1053; Aug. 20, 1967). The material is slender, and greatly resembles the illustration of *B. tenella* in Rhodora **2**: pl. 15, f. 6 (1900). The leaves are subulate, purplish on the lower part of the stem, green on the middle and upper part. Anthers very from purplish to dark yellow. Bicknell (Bull. Torr. Cl. **42**: 33. 1915, and **46**: 423. 1919) found similar intermediate plants on Marthas Vineyard and Long Island. On Cape Cod, *Bartonia paniculata* has been previously known from Barnstable and Dennis.

**Myosotis scorpioides* L. Densely covering extensive areas in Santuit R., Cotuit (no. 752). The European forget-me-not has not been recorded from the Cape.

**Orobanche uniflora* L. Springy hummock below *Chamaecyparis*, at edge of brackish marsh, Bumps R., Osterville (no. 678). Known southward to the Taunton and New Bedford area in Bristol County.

Jasione montana L. Sandy fields, Osterville (no. 817). For many years this handsome blue-flowered plant was known only in the vicinity of the cemetery at East Sandwich. It now appears to be spreading rapidly, and is abundant at the south end of Hamblins Pond in Marstons Mills.

Erigeron pulchellus Michx. On knoll at edge of swamp at "Spring Hill", East Sandwich (no. 720). In the dry summer of 1927, the plants occupied an area about 2 feet square, and I found a single flower. In 1968, a wet summer, everything was overgrown and I could find no trace of the plants. The nearest locality is New Bedford.

OSTERVILLE, MASS. 02655

ADDITIONS AND NOMENCLATURAL CHANGES IN THE FLORA OF SOUTHERN FLORIDA — I.

ROBERT W. LONG[1]

The purpose of this paper is to validate certain nomenclatural changes, and to record additions and certain taxonomic reinterpretations in the vascular flora of southern Florida. These changes and additions have resulted from preliminary studies that have been part of the preparation of a manual of the flora of tropical Florida. The flora of southern Florida is a rich one for so small an area (Long, Lakela, and Broome, 1969), and it was of special interest to J. K. Small. Numerous nomenclatural and taxonomic revisions have been necessary, but it will not be possible to report here all the changes from names used by Small in his manuals dealing with this flora (1903, 1913a, 1913b, and 1933). Other additions or changes requiring validation may be necessary as work progresses; the present paper includes references only for certain dicotyledonous families.

RANUNCULACEAE

Clematis

The populations of *Clematis baldwinii* are highly variable in peninsular Florida, where the species is endemic, but two recognizable morphological extremes occur. These are separable on the basis of sepal length and leaf shape, but they are connected by morphologically intermediate plants. Gray (1895) made reference to the broad leaf form of *C. baldwinii* but did not name it. Erickson (1943) placed the species in his monotypic subsect. Baldwinianae, sect. Viorna, separated from its apparent nearest relative the western

[1]Contribution No. 47 from the Botanical Laboratories, University of South Florida. Research was supported in part by grant No. GB-2742 from the National Science Foundation. Much of this investigation was carried out at the Arnold Arboretum and Gray Herbarium, Harvard University, while the author held a Mercer Research Fellowship in the Arnold Arboretum, 1968.

C. fremontii S. Wats. which has all leaves simple and ovate to orbicular in shape.

Additional field work and an analysis of population variability would be very desirable in *C. baldwinii*. A possible third variety characterized by very small flowers, sepals less than 2 cm long and with linear leaves, occurring on the white sand scrub of central Florida and extending into southern Florida, may also deserve varietal recognition. It is possible that var. *latiuscula* may represent hybrids with broad leaf forms of *C. crispa* L. or *C. reticulata* Walt., or may even represent remnants of wholly different population systems.

Sepals 3-4 cm long; leaves mostly linear to narrowly lanceolate. .... *C. baldwinii* var. *baldwinii*

Sepals 4-5.5 cm long; leaves mostly elliptic-lanceolate to narrowly ovate. ..... *C. baldwinii* var. *latiuscula*

CLEMATIS BALDWINII var. BALDWINII T. & G., Fl. N. Am. **1**: 8. 1838.

Viorna baldwinii Small, Fl. SE. U. S. 439, 1331, 1903.

DADE CO.: east boundary Everglades National Park, Dec. 23, 1955, *F. C. Craighead* and *L. E. Arnold, s.n.* (GH); HILLSBOROUGH CO.: northwest of Tampa near junction of Waters street and Hulsey road, May 19, 1962, *O. Lakela* 25969 (GH, USF); LEE CO.: occasional erect in pine-palmetto flatwoods 10 mi wsw Salvista, May 13, 1958, *R. Kral* 6542 (GH); POLK CO.: partly cleared pineland close to RR tracks, just off Lakeland city limits, infrequent, March 12, 1961, *O. Lakela* 23836 (GH, USF).

CLEMATIS BALDWINII var. **latiuscula** R. W. Long, var. nov.

A typo differt foliis integris; lamina ovato-attenuata, 7.5-8.0 cm longa, 2.0-2.4 lata, breviter petiolata; supera folia sessilia; lamina manifeste palmatim trinervis, reticulata; sepala longa 5.0-5.4 cm, lata 6-8 mm; pedunculi 18-22 cm longi, nudiusculi.

TYPE, LEVY CO. FLA. In low, open pineland, S 34, T 16S, R 16E, April 25, 1959, *G. R. Cooley* 6549 and *R. J. Eaton*. In Gray Herbarium, isotype in USF.

CITRUS CO.: 2 mi w Sumter Co. line on hwy 48 between Bushnell and Floral City on shoulder of road and edge of wood, April 29, 1958, *G. Cooley* 6069, *C. Wood* and *K. Wilson* (GH, USF); HENDRY CO.: near

Goodno, hammock, April 8, 1940, *D. E. Eyles* 6819 (GH); HILLSBOROUGH CO.: sand barren beyond Ballast Point, W. Tampa, May 30, 1923, *J. R. Churchill s. n.* (GH); SARASOTA CO.: Sarasota, Dec. 25, 1942, *A. E. Perkins, s. n.* (GH); VOLUSIA CO.: Port Orange, May 13, 1895, *F. C. Straub* 145 (GH).

POLYGALACEAE

Polygala

The genus is well-represented in southern Florida by 17 species and a number of infraspecific taxa. Several are endemic to the limestone soils that support pineland and hammock vegetation. *Polygala boykinii*, for example, includes three well-marked varieties in southern Florida, two of which are endemic. They may be separated as follows:

1. Lower-most leaves elliptic-obovate to suborbicular, often mucronate.
   2. Leaf-blades elliptic-obovate, upper blades linear. ..... *P. boykinii* var. *boykinii*
   2. Leaf-blades suborbicular, upper blades usually narrowly lanceolate. ..... *P. boykinii* var. *suborbicularis*
1. Lower-most leaves subulate to linear or linear-lanceolate. ..... *P. boykinii* var. *sparsifolia*

POLYGALA BOYKINII var. BOYKINII Nutt. Jour. Acad. Phil. 7: 86. 1834.

Pinelands, Fla. to La, Ga.

HILLSBOROUGH CO.: along country road from 30th st. and Skipper Ave., low seasonally wet, weedy roadside, June 17, 1962, *O. Lakela* 25131 (USF); MONROE CO.: low area near Fla 94, Pinecrest, ca 6 mi w of Dade-Monroe county line T54S, R 34 E, Dec. 29, 1959, *D. B.* and *S. S. Ward* 1176 (USF).

POLYGALA BOYKINII var. **suborbicularis** R. W. Long, var. nov.

A typo differt foliis infernis suborbicularibus 0.8-1.4 cm longis, 0.6-0.8 cm latis, superis foliis anguste lanceolatis raro linearibus, 0.9-1.2 longis, 0.3-0.5 cm latis.

TYPE, LEE CO. FLA. Pinewoods, 10 mile camp, near Everglades, March 23-26, 1905, *A. A. Eaton* 1384. In Gray Herbarium.

HERNANDO CO.: west of Weeki Wachee springs, frequent, March 19, 1958, *G. R. Cooley* 5650 and *J. Monachino* (GH, USF); LEE CO.: vicinity of Fort Myers, in hammock, April 3, 1916, *Jeanette P. Standley* 129 (GH) (A smaller leaf-form but similar to the type); MONROE CO.: Big Pine Key in limerock outcropping under *Pinus elliottii* and *Sabal palmetto*, May 3, 1958, *G. Cooley* 6195, *et al.* (GH, USF).

POLYGALA BOYKINII var. SPARSIFOLIA Wheelock, Mem. Torr. Club 2: 121. 1891.

TYPE, MONROE CO., FLA. Coral soil, Cudjoe Key, *A. H. Curtiss, s.n.* (Isotype, GH!).

P. praetervisa Chodat, Mem. Soc. Phys. Genève 31(2): 140. 1891.

P. flagellaris Small, Bull. N. Y. Bot. Gard. 3: 427. 1905 (p.p. incl. type).

P. sparsifolia Small, Fl. SE. U. S. 686, 1333. 1903.

Endemic to extreme southern peninsular Florida and the Florida Keys, this is perhaps the most distinctive variety in the species.

DADE CO.: Everglades National Park near Homestead, Miami oolite and solution holes, hammock and pineland association, Oct. 16, 1962, *G. Cooley* 9410, *et. al.* (GH, USF) (Intermediate form to typical variety); MONROE CO.: Big Pine Key, pine-palm woods, May 24, 1952, *W. B. Robertson* 274 (GH); Big Pine Key, pineland, April 19, 1942, *C. E.* and *M. S. Eyles* 8201 (GH); Big Pine Key, pinewoods, Feb. 21, 1936, *E. P. Killip* (GH).

A second species that includes two endemic varieties in Florida is *Polygala grandiflora*. Small described a number of endemic species from this complex that may be referred to one or the other of the varieties described below.

1. Wings greenish or purplish-tinged.
   2. Leaf blades elliptic or elliptic-lanceolate. ..... *P. grandiflora* var. *grandiflora*
   2. Leaf blades linear or linear-lanceolate. ..... *P. grandiflora* var. *angustifolia*
1. Wings dark purple. ..... *P. grandiflora* var. *leiodes*

POLYGALA GRANDIFLORA var. GRANDIFLORA Walt., Fl. Car. 179. 1788.

P. cumulicola Small, Bull. Torr. Bot. Club 51: 381. 1924.

P. miamiensis Small, in Blake, N. Am. Fl. 25(5): 340. 1924.

Small stated that *P. cumulicola* differs from *P. grandiflora* in having deep-rose purple wings and a short raceme, which is true (isotype GH!). Additional study may warrant recognition of this race as a variety of *P. grandiflora*, however at present these characters do not seem to mark a definite

taxon within the species sufficiently to necessitate taxonomic recognition.

POLYGALA GRANDIFLORA var. ANGUSTIFOLIA T. & G., Fl. N. Am. 1: 671. 1840.

P. grandiflora var. *leptophylla* Chodat, Mem. Soc. Phys. et Hist. Nat. Genèv. 31: 57. 1893.

P. corallicola Small, Bull. N. Y. Bot. Gard. 3: 425. 1905.

POLYGALA GRANDIFLORA var. LEIODES Blake, N. Am. Fl. 25: 339. 1924.

P. grandiflora var. *grandiflora* is found throughout a number of the Southeastern states, but *P. grandiflora* var. *angustifolia* and *P. grandiflora* var. *leiodes* are generally confined to extreme southern Florida and the West Indies.

EUPHORBIACEAE

Croton

Six species occur in southern Florida, and the most variable of these is *Croton glandulosus*, a wide-spread tropical weed species that includes two varieties endemic to the dry pinelands. The typical variety appears to be more common in the maritime sands suggesting ecotypic separation of the varieties. However, *C. glandulosus* var. *glandulosus* may be found in various sites, as pinelands, old fields, sandy soil, and disturbed sites. The varieties may be separated as follows:

1. Calyx and fruit pubescent.
   2. Leaf blades stellate-pilose on both surfaces, margins serrate to dentate. ..... *C. glandulosus* var. *glandulosus*
   2. Leaf blades densely stellate-pubescent on both surfaces, margins crenate-serrate. ..... *C. glandulosus* var. *simpsonii*
1. Calyx and fruit smooth or nearly so. ..... *C. glandulosus* var. *floridanus*

CROTON GLANDULOSUS L. var. GLANDULOSUS

COLLIER CO.: beach area of Marco Island, off US 92; construction site with destruction of native vegetation, July 1, 1967, *O. Lakela* 30839 (USF); vicinity of Naples, recently cleared weedy sandlot with *Centrosema, Euphorbia, Cassia,* weed in vacant lot, Oct. 9, 1962, *G. R. Cooley* 8990, *R. Eaton,* and *O. Lakela* (USF); DADE CO.: sandy beach, Key Biscayne, Nov. 2, 1965, *F. C. Craighead* (USF); HIGHLANDS

CO.: frequent in grove by SAL RR, 2.1 m n. of Sebring on US alt 27, T 34S, R 29E, June 8, 1964, *D. Burch* 384 (USF); PALM BEACH CO.: w. side of Dreher Park, West Palm Beach, disturbed ground, sand, full sun, 7 dm tall, Aug. 29, 1967, *Paul Cassen* 180 (USF).

CROTON GLANDULOSUS var. SIMPSONII Ferg., Rep. Mo. Bot. Gard. **12**: 51. 1901.

BREVARD CO.: Melbourne Beach, n of park area, with escaped cultigens, June 7, 1964, *O. Lakela* 27206A (USF); DADE CO.: pineland associated with *Acalypha, Neptunia, Schrankia,* pubescence coarse, Old Cutler Road, near Deering Hammock, July 17, 1964, *O. Lakela* 27275 (USF).

CROTON GLANDULOSUS var. **floridanus** (Ferg.) R. W. Long, stat. nov.

C. floridanus Ferguson, Rep. Mo. Bot. Gard. **12**: 50, pl. 15. 1901.

This variety is readily separable from the other ones by means of the glabrous or nearly glabrous sepals of the pistillate flowers, and glabrous fruits. All populations of *C. glandulosus* in southern Florida appear to be distinct from the northern and central Florida *C. glandulosus* var. *septentrionalis* Muell. Arg.

COLLIER CO.: under trees, Vanderbilt Beach, n Naples, leeward side of dunes, Sept. 8, 1967, *O. Lakela* 31069, (USF); Marco Island, beach area; plants frequent in sandy openings, Sept. 27, 1964, *O. Lakela* 27509 (USF); MANATEE CO.: Anna Maria Island, coastal dunes and white sand beaches, Jan. 15, 1967, *R. W. Long* 2367, *R. Broome, C. Croley* (USF); MONROE CO.: Murray Key, Florida Bay off Flamingo, open drier site with salt grasses and succulents, May 8, 1965, *O. Lakela* 28599, *R. W. Long,* and *F. Craighead;* PINELLAS CO.: Fort DeSoto Park, s end, capsules glabrous, Sept. 10, 1963, *R. Thorne, R. Long, O. Lakela* 26282 (USF).

MYRTACEAE

Myrcianthes

The two species of *Myrcianthes* reported as endemic for Florida (Wilson, 1961) are very probably merely local variants of *M. fragrans*, a wide-ranging species in the American tropics. They differ from the typical form chiefly in having slightly longer petioles and by producing cymes usually 7-flowered instead of 3-flowered. However, there

is some justification for maintaining *M. simpsonii* because the cymes are several-flowered, usually 10-14; this would then be our only endemic variety of *M. fragrans*. There is less justification for maintaining *M. dicrana*, and it is therefore placed in synonomy under the typical variety.

MYRCIANTHES FRAGRANS (Sw.) McVaugh — Shrubs or trees up to 20 m tall, usually less, with reddish-brown or light-brown bark. Leaves narrowly obovate to elliptic-cuneate 1-8 cm long, acute or obtuse, pale green above, slightly paler beneath. Flowers in cymes with 3-14 flowers; sepals about 1-2 mm long, corolla about 1 cm wide. Berry globose or ellipsoidal. Hammocks, s Fla, tropical Amer.

Corolla less than 1 cm wide, cymes usually 3-7 flowered. ..... var. *fragrans*

Corolla over 1 cm wide, cymes several flowered, usually 10-14. ..... var. *simpsonii*

MYRCIANTHES FRAGRANS (Sw.) McVaugh var. FRAGRANS, Fieldiana: Bot. 29: 485. 1963.

Anamomis dicrana Britton, Britton and Shafer, N.A. Trees, 728, *fig. 668*. 1908. (*Eugenia dicrana* Berg.)

DADE CO.: Everglades, Paradise Key, May 5, 1908, *E. A. Bessey* (A); Everglades National Park near Long Pine Key, 5½ miles w, 2 m n of Paradise Key, altitude 6 ft. in hammock in pinewoods, limerock with pockets of soil in cracks, considerable organic litter, assoc. with *Ficus brevifolia, Metopium toxiferum, Rapanea, Dipholis*, tree up to 7 ft. irregularly branched, April 22, 1958, *A. Traverse* 586 (GH); INDIAN RIVER CO.: near Vero Beach, abundant in dense scrub; scrub or tree up to 6 m tall, bark flaky, brownish; galled fruits orange, July 2, 1949, *L. J. Brass* 20582 (GH).

MYRCIANTHES FRAGRANS var. **simpsonii** (Small) R. W. Long, comb. nov.

Anamomis simpsonii Small, Torreya **17**: 222. 1917.
Myrcianthes simpsonii (Small) K. A. Wilson, Jour. Arnold Arb. **41**: 276. 1961.

DADE CO.: Arch Creek, May 1918, *C. J. Simpson* (A); hammock along Arch creek, May 12, 1917, *J. K. Small* 8287 (GH); MONROE CO.: North Key Largo ca 3 m from left turn of US I, coral limestone, *Sweitenia, Gouania, Dalbergia*, 4 m high, Oct. 13, 1962, *G. R. Cooley* 9293, *J. R. Eaton, O. Lakela* (GH, USF).

PLUMBAGINACEAE

Limonium

Two Limoniums have been described from Florida material: *L. carolinianum* (Walt.) Britt. var. *angustata* A. Gray, and *L. nashii* Small. In his monograph Blake stated that *L. carolinianum* has a glabrous calyx and deltoid-obtuse lobes. Gray based his variety (type, GH!) on the narrowness of the leaves. Small described *L. nashii* as having pubescent calyx lobes, at least at the base; *L. trichogonum* Blake supposedly has still more strongly pubescent calyx. Finally, to complicate further the taxonomy is *L. obtusilobum* (type, GH!) supposedly with a shorter calyx that is pilose-pubescent. Blake stated that the chief characters for specific discrimination in *Limonium* were pubescence, size and form of calyx and shape of the calyx lobes, shape of flowering bractlets, and aggregation of flowers.

Ahles incorrectly reduced *L. obtusilobum* to a variety of *L. carolinianum*. The former is characterized by a line of pubescence along the sepal and is hirsute on the blunt-shaped sepals; the latter species is entirely glabrous and is so characterized. Ahles then made *L. carolinianum* var. *angustata*, which was originally characterized by narrowness of the leaves, a variety of *L. nashii*, a species that was originally based on a sparingly pubescent calyx tube.

The aggregation of flowers is a poor character for separating taxa because there is continual variation from one extreme to another. Pubescence of the calyx is also unstable. After examination of type collections in GH and of collections from southern Florida, it is apparent that only two varieties of *L. carolinianum* are worthy of recognition: *L. carolinianum* var. *angustata* (Gray) Blake representing a narrow leaf, dwarfish race endemic to the Florida Keys and southern peninsular Florida, and *L. carolinianum* var. *carolinianum* the larger more robust race.

Leaves lanceolate-elliptic to obovate-spatulate; floral internodes less than 5 mm long. ..... var. *carolinianum*

Leaves linear-lanceolate to narrowly elliptic; floral internodes about 5 mm long. ..... var. *angustatum*

LIMONIUM CAROLINIANUM (Walt.) Britt. var. CAROLINIANUM

L. nashii Small, Bull. Torr. Bot. Club 24: 491. 1897.
L. trichoganum Blake, Rhodora 18: 61. 1916.
L. nashii var. *trichoganum* Blake, Rhodora 25: 58. 1923.
L. carolinianum var. *nashii* (Small) Boiv. Nat. Canad. 93: 643. 1966.

LIMONIUM CAROLINIANUM var. ANGUSTATUM (A. Gray) Blake, Rhodora 25: 56. 1923.
Statice brasiliensis var. *angustatum* A. Gray, Synopt. Fl. N. Amer. 2(1): 54. 1878.
L. angustatum (A. Gray) Small, Bull. Torr. Bot. Club 24: 488. 1897.
L. obtusilobum Blake, Rhodora 18: 63. 1916.
L. carolinianum var. *obtusilobum* (Blake) Ahles, Journ. Elisha Mitch. Sci. Soc. 80: 173. 1964.
L. nashii var. *angustatum* (A. Gray) Ahles, Journ. Elisha Mitch. Sci. Soc. 80: 173. 1964.

TYPE: Pine Key. Blodgett. In Gray Herbarium!

LEE CO.: on wet mucky soil of mangrove swamp, Bokeelia Island, Dec. 31, 1956, *R. Kral* 3901 (GH); MONROE CO.: Big Pine Key, saline flats south of Inn, Dec. 29, 1953, *E. P. Killip* 43400 (GH); PINELLAS CO.: salt flats, Snug Harbor, Nov. 14, 1959, *R. K. Godfrey* 59192 (GH).

SAPOTACEAE

Bumelia

The United States species of *Bumelia* were revised by Clark (1942) and later by Cronquist (1945). *Bumelia angustifolia* was described by Nuttall from a tree that was common in Key West according to Blodgett. It has leaves unusually small and narrow linear-oblong and obtuse, with the blade 2.5-3.0 cm long and up to 1 cm wide that come out in clusters from the center of the preceding bud. Nuttall was the first to recognize the distinctiveness of this race. All specimens seen of this taxon occur in southern Florida, and apparently it is endemic to the lower Florida Keys and the Cape Sable area. *Bumelia celastrina* var. *celastrina* also occurs in this area but not nearly so commonly, al-

though it is abundant farther north in peninsular Florida. The two races intergrade although the extremes are easily distinguished. *B. celastrina* var. *angustifolia*, with its much reduced, narrower leaves, appears to be a distinct ecotype adapted to coastal hammocks and pinelands.

The type for *B. celastrina* (photo, GH!) is from Mexico and is of a large-leaved plant with blades 3-4 cm long. Possibly, Cronquist drew broad, inclusive circumscriptions that incorporate many otherwise distinctive races, and probably population structure is considerably more complex than his treatment would infer. Certainly the Florida Keys race is morphologically separable from the typical variety.

BUMELIA CELASTRINA H.B.K. Trees or shrubs up to 8 m tall with glabrous stems. Leaves evergreen, fascicled, blades oblanceolate to oblanceolate-spatulate, 1-4 cm long, glabrous. Flowers few-several in axillary cymes or umbels; calyx lobes 2 mm long, ovate, corolla 3-4 mm wide, lateral lobes irregularly toothed; staminodia 2-3 mm long, lacerate. Styles 2.5-4 mm long. Berry cylindrical 7-13 mm long.

Leaf blades oblanceolate to spatulate 2-4 cm long, slightly pubescent when young. ..... var. *celastrina*

Leaf blades linear-oblong, obtuse, mostly 1-2 cm long, glabrous when young. ..... var. *angustifolia*

BUMELIA CELASTRINA var. **angustifolia** (Nutt.) R. W. Long, stat. nov.

Bumelia angustifolia Nutt., N. Am. Sylva 3: 38, *pl. 93.* 1849.

CHARLOTTE CO.: Boca Grande, golf links, small tree, Jan. 20, 1920, *J. S. Ames* (A); DADE CO.: East Cape, Nov. 1912, *C. T. Simpson* (A); 2 mi e of Cape Sable, Nov. 1912, *C. T. Simpson;* MONROE CO.: Summerland Key, July 2, 1956, *C. K. Brizicky* 355, & *W. L. Stern* (A); Little Torch Key, hammock, tree 15-18 ft high, 7 in. dbh, June 29, 1956, *G. K. Brizicky* 344 & *W. L. Stern,* (A); Big Pine Key, small tree 10 ft high, 3 in diam, dry pinelands near Myrtle and Wesley's place, June 22, 1956, *G. K. Brizicky* and *W. L. Stern.*

LOGANIACEAE

Cynoctonum

Three species, including one new one, occur in southern

Florida, and they may be distinguished as follows:

Leaf blades narrowly lanceolate to ovate-orbicular, sessile. ..... 1. *C. sessilifolium*

Leaf blades narrowly lanceolate to ovate-lanceolate or ovate, short-petioled.

Lower leaves ovate-lanceolate or ovate, fleshy, larger blades tending to cluster at the base in a rosette; inflorescence mostly 2-4 cm long. ..... 2. *C. succulentum*

Lower leaves lanceolate to elliptic or ovate, not clustered at the base; inflorescence mostly 4-6 cm long. ..... 3. *C. mitreola*

1. CYNOCTONUM SESSILIFOLIUM (Walt.) J. F. Gmel.

Three varieties are present in southern Florida:

1. Leaf blades elliptic to ovate or orbicular.
   2. Leaf blades mostly 2-4 cm long, apex obtuse. ..... var. *sessilifolium*
   2. Leaf blades mostly 1-1.5 cm long, apex acute. ..... var. *microphyllum*
1. Leaf blades narrowly lanceolate. ..... var. *angustifolium*

CYNOCTONUM SESSILIFOLIUM var. SESSILIFOLIUM.

Ditches, low ground, wet places, a coastal plain plant, Fla to La, Tex, and Va. Widely distributed in Fla.

CYNOCTONUM SESSILIFOLIUM var. **microphyllum**, R. W. Long, var. nov.

A typo differt caule simplici, foliis sessilibus, parvulis, 1-1.5 cm longis, pro parte maxima minus quam 1 cm longis, apicis acutis; laminis ellipticis vel late lanceolatis; inflorescentiis aliquot ramosis, ramis minus quam 2 cm longis per anthesin.

TYPE: BREVARD CO. FLA.: 4 miles west of Melbourne, occasional on moist sandy peat of pine flatwoods; flowers white. August 22, 1958, *R. Kral* 7961. In Gray Herbarium, isotype in USF.

Stems simple, leaves sessile, small, the blades 1-1.5 cm long, mostly less than 1 cm long with acute to broadly acute apex; blades elliptic to broadly lanceolate, inflorescence few-branched, the branches less than 2 cm long at flowering.

FLORIDA: CALHOUN CO.: grassy swamps, Sept. 1, 1889, *Chapman Herb.* 2824[a] (GH); CITRUS CO.: 5 mi s Homosassa; frequent on moist sandy peat of clearing near cypress dome, August 10, 1958, *R. Kral* 7764 (GH, USF); DADE CO.: Miami, July 1877, *A. P. Garber* (GH);

DUVAL CO.: Baldwin, August 6, 1895, *G. V. Nash* (GH); INDIAN RIVER CO.: 7 mi. west of Vero Beach, frequent on moist sandy peat of grass-sedge bog, August 29, 1957, *R. Kral* 5587 (GH, USF); LEE CO.: around flatwood ponds, Ft. Myers, July-Aug. 1900, *A. S. Hitchcock* 214 (GH); LEVY CO.: along Rt. 24, 3 mi southwest of Otter Creek, sandy soil along highway right-of-way, Sept. 13, 1954, *R. E. Perdue Jr.* 1732 (GH); MONROE CO.: Key West, *Blodgett* (GH); OSCEOLA CO.: pond on prairie, Aug. 4, 1903, *A. Fredholm* 5947 (GH).
GEORGIA: DOUGLAS CO.: acid bog-meadow 2 mi e of Villa Rica, flowers white, July 27, 1948, *A. Cronquist* 5563 (GH).
LOUISIANA: BEAUREGARD PARISH: wet sandy soil along shallow ditch about 10 mi south of De Ridder, July 21, 1938, *D. S.* and *H. B. Correll* 9673 (GH); VERNON PARISH: 2 mi. w of Leander, grassy field with wet areas from springs; woody vegetation removed except for a few pines, frequent, flowers white, July 7, 1950, *G. L. Webster* and *R. L. Wilbur* 3235 (GH).
MISSISSIPPI: JACKSON CO.: Ocean Springs, July 27, 1896, *C. L. Pollard* (GH).
NORTH CAROLINA: CARTARET CO.: savannah, at Newport, Aug. 6, 1938, *R. K. Godfrey* 5786 (GH).
TEXAS: HOUSTON CO.: Grapeland, sandy open bogs, Sept. 22, 1917, *E. J. Palmer* 12849 (GH).
SOUTH CAROLINA: HORRY CO.: Conway, savannah, Sept. 1, 1940, *P. O. Schallert* (GH).

This variety appears as rigidly erect, simple plants with much reduced leaves. In distribution it appears to be similar to that of the typical variety although it apparently is ecotypically adapted to wet, sandy or more often peaty soil, rather than the chiefly pineland habitat of the typical race. Both morphologically and ecologically it is readily separable from the other two varieties.

CYNOCTONUM SESSILIFOLIUM var. ANGUSTIFOLIUM T. & G.

Mitreola sessilifolia β angustifolia T. & G., Fl. N. Amer. 2: 45. 1841.

Cynoctonum angustifolium Small, Bull. Torr. Bot. Club 23: 129. 1896.

Wet soil, Fla to Ga on the coastal plain.

FLORIDA: DADE CO.: southwest of Homestead, Everglades National Park, oolite depressions, trailside, Oct. 16, 1962, *O. Lakela* and *F. C. Craighead* (USF); Everglades National Park, pinelands, plant reddish before drying, Oct. 12, 1962, *G. R. Cooley* 9223, *R. Eaton*, *J. Ray*, *R. Long*, and *O. Lakela* (USF); HERNANDO CO.: one mile n of Weeki

Wachee Springs, occasional on moist sandy pineland pond border, June 9, 1958, *R.* and *Mabel Kral* 6778 (USF).

2. **Cynoctonum succulentum,** R. W. Long, sp. nov.

Planta annua 2-4 dm alta, caulis simplex, raro ramosus super. Folia elliptica ad ovata, 3-5 cm longa, 1.5-2.0 lata, glabra, succulenta, infima rosulata, caulina folia vix demi-nuta, omnia petiolis brevissimis. Inflorescentia cyma ramosa spicis brevibus pro parte maxima 2-4 cm longis, dense secunda; sepala 0.5-0.75 mm longa, corolla 1-1.5 mm longa, bractea 1-1.5 mm longa paulatim decrescens, plerumque succulenta. Capsula plerumque mitriformis.

TYPE: In pine barrens, near Manatee, Florida, June 11, 1890, *J. H. Simpson.* In Gray Herbarium.

Annual herbs with smooth stems 2-4 dm tall, simple, seldom branched above. Leaves elliptic to ovate, 3-5 cm long, 1.5-2.0 cm wide, acuminate, smooth, succulent; lower leaves forming a basal rosette, petioled, upper stem leaves not much reduced in size, short-petioled or subsessile; stipules much reduced. Inflorescence a terminal, peduncled cyme, flowers spiked along one side of the branches, the branches usually 2-4 cm long, flowers densely arranged along the axis; sepals 0.5-0.75 mm long, corolla white, 1.0-1.5 mm long, somewhat funnel-form to urceolate; stamens 5, included; ovary 2-locular, styles 2, very short and fused at the tip to form a common stigma; bracts 1.0-1.5 mm long, gradually tapering, usually succulent. Capsule 3-4 mm long, exserted, somewhat mitriform, many- seeded. In drier sites, pinelands, less commonly in moist soil, glades, endemic to southern peninsular Florida.

COLLIER CO.: abundant on wet muddy edges of marsh; corolla white, East Henson Marsh, Feb. 14, 1946, *L. J. Brass* 15972 (GH); DADE CO.: Royal Palm Hammock, June 29, 1915, *J. K. Small, C. Mosier, G. Small* (GH); Everglades, 10 mi nw of Hialeah on route 27, common, associated with *Asclepias incarnata;* flowers white, August 24, 1951, *Grady Webster* 4237 (GH); glades south of Long Pine Key, not common, April 24, 1952, *W. B. Robertson, Jr.* 211 (GH); LEE CO.: vicinity of Fort Myers, in pineland, May 22, 1916, *Jeanette Standley* 200 (GH); PINELLAS CO.: sandy soil near Maximo point, St. Petersburg, Sept. 10, 1954, *R. F. Thorne* 15407 (GH).

Cynoctonum succulentum appears strikingly different from the related, widespread *C. mitreola* because of its thicker, more succulent leaves, the larger ones often clustered towards the base forming a rosette, and because the leaves have very short petioles, or are subsessile, the base almost truncate, and because of its more restricted inflorescence. Although *C. mitreola* (photo of type in GH!) is admittedly a highly variable species, its leaves are more often lanceolate, acute, and definitely petioled, and never clustered at the base; in addition, it is often branched near the top, and the inflorescence is usually widely branched. The leaves are membranous, and cymes often arise from the lower axils. The two species appear to be ecologically distinct: *C. succulentum* is found in pine barrens and drier soil more frequently than not, and *C. mitreola* is typically found in drainage ditches, swamps, and moist sites.

3. CYNOCTONUM MITREOLA (L.) Britt. Mem. Torr. Bot. Club 5: 258. 1894.

Low ground, wet places, Fla to Va, Ark, Mex, WI. This is the most common species of *Cynoctonum* in southern Florida, and is the most variable, particularly in leaf shape and size. Apparent hybrids with *C. sessilifolium* are found in Florida, also. In practice, these putative hybrids are usually referred to *C. mitreola*.

APOCYNACEAE

Urechites

The tropical genus *Urechites* is represented in the southern Florida flora by the extremely variable *U. lutea* (L.) Britt., a vine or scrambling shrub with bright green leaves and tubular yellow corollas. Two readily separable varieties can be identified, however, representing apparently ecotypically differentiated races:

Leaf undersurfaces, sepals, and follicles glabrous or barely pubescent. ..... var. *lutea*

Leaf undersurfaces, sepals, and follicles copiously pubescent. ..... var. *sericea*

URECHITES LUTEA (L.) Britt. var. LUTEA Bull. N. Y. Bot. Gard. 5: 316. 1907.

Twining vines, generally in hammocks, mangroves associations, southern Florida, Florida Keys, West Indies.

URECHITES LUTEA var. **sericea** R. W. Long, var. nov.

A typo differt foliis tomentosis vel quidem pilosissimis; calyce et pedunculis hirsutis, corollae tubo pilis mollibus.

TYPE: vicinity of La Valle, Tortue Island, Haiti. Twining on shrubs to height of 15 ft., flowers yellow, thicket east of harbor. Dec. 28, 1928, Jan. 9, 1929, *E. C.* and *G. M. Leonard* 11642. In Gray Herbarium.

Urechites jaegeri Muell.-Arg. Linnaea **30**: 444, 1860, pro parte.

Urechites pinetorum Small, Addisonia **4**: 21, *pl. 131*. 1919.

Differing from the typical variety by having leaves tomentose underneath, or at least thickly pubescent; calyx and peduncle hirsute, corolla tube with soft hairs; fruits covered with soft, silky pubescence.

The new variety is abundantly distinct, at least in southern Florida, and apparently in the West Indies; var. *sericea* frequently occurs in rocky often limestone soil, while var. *lutea* is found more frequently in moist soil. Morphological intermediates are found but they apparently are not common.

FLORIDA: DADE CO.: pinelands west of Coconut Grove, May 15, 1918, *J. K. Small* (GH); Coconut Grove, 1910, *Miss C. Rotham* (A); Homestead, pineland area between Homstead and Florida City near S. R. 27, June 4, 1966, *R. W. Long* 1674 (USF).

BAHAMAS: ANDROS ISLAND, near Niccols Town, in pine yards and along roadsides, June 14-16, 1965, *R. W. Long* 1367 (USF).

JAMAICA: ST. CATHERINE PARISH: Mt. Diablo, site of Blue mountain, August 21, 1965, *H. A. Hespenheide* 1379 (GH); Manchester, Red Mould Forest Reserve, s of Troy in open place, climber to 12 ft, corolla yellow, April 23, 1956, *W. T. Stern* 917 (GH); ST. ANN PARISH: Moneague, Jan. 23, 1952, *F. W. Hunnewell* 19786 (GH); limestone turn-around area alt. 1500, Minea area near Lydford p. o. Dec. 20, 1953, *R. A. Howard* and *G. R. Proctor* 13489 (GH); near Casteltou, June 26, 1915, *W. Harris* 12085 (GH).

CUBA: ISLE OF PINES, swamp about 2 km due n of Nueva Gerona, Mar. 18, 1953, *E. P. Killip*, 43140 (GH); Buenas Aires, in brushland, July 10, 1929, *F. M. Salvoza* (GH); Soledad, Cienfuegos, Aug. 4, 1927, *J. G. Jack* 5230 (GH); rocky pasture, Soledad Cienfuegos, Sept. 2, 1927, *J. G. Jack* 5413 (GH); Havana, camino del Morro,

Santiago de Cuba, June 1944, *Hno. Clemente,* 3689 (GH); Santa Clara, brushy field, July 13, 1936, *L. B. Smith, A. R. Hodgdon,* (GH); Oriente Province, Cerro de Miraflores, Cananova, July, 1942, *Hno. León* 21106 (GH).

HISPANIOLA: SANTO DOMINGO: in thickets, May 13, 1929, *E. L. Ekman,* 12453 (A); MONET CRISTI: semiscandent plant, elevated coral reefs near Rio Yaqee del Norte, Oct. 23-24, 1946, *R.* and *E. S. Howard* 9584 (GH).

CONVOLVULACEAE

Bonamia

Although Myint has pointed out that *Stylisma* and *Bonamia* may be separated by means of differences in the shape of cotyledons, otherwise the two genera are closely similar and there appears to be no sound reason for maintaining them as separate taxa. Intermediate species serve to form a continuous pattern of variation between the two groups.

BONAMIA **abdita** (T. Myint) R. W. Long, comb. nov.

Stylisma abdita T. Myint, Brittonia **18**: 107. 1966.

Stictocardia

A specimen of *S. tiliifolia* Hall. f. from Key West, Fla. in the Gray Herbarium suggests that this species may be naturalized in the Florida Keys or southern peninsular Florida. No other collections have been seen, however.

BORAGINACEAE

Heliotropium

Three heliotropes are found in southern Florida, *H. angiospermum* Murr., *H. curassavicum* L., and *H. polyphyllum* Lehm. The latter species is represented by two readily distinguished varieties:

Stems erect, often strict. ..... var. *polyphyllum*
Stems spreading-decumbent or prostrate. ..... var. *horizontale*

HELIOTROPIUM POLYPHYLLUM Lehm. var. POLYPHYLLUM in Neue Schr. Naturf. Ges. Halle iii, II, 9. 1817. including *H. polyphyllum* var. *leavenworthii* (Torr.) A. Gray, Proc. Amer. Acad. Arts & Sci. **10**: 49. 1874.

This is a tropical species that occurs in coastal areas, low

hammocks, and pineland in moist soil; var. *leavenworthii* is merely the form with yellow rather than white corollas, said to be "strict", but not appearing to be worthy of taxonomic distinction from the typical variety.

HELIOTROPIUM POLYPHYLLUM var. **horizontale** (Small) R. W. Long, stat. nov.

Heliotropium horizontale Small, Bull. N. Y. Bot. Gard. 3: 435. 1905.

TYPE: pinelands between Cutler and Camp Longview, Nov. 1903, Small & Carter 742 (NY, photo GH!)

DADE CO.: pinelands about Cox hammock, June 24, 1915, *J. K. Small* 6579, *C. Mosier*, and *G. Small* (GH); LEE CO.: Seacoast, Sanibel, July-Aug 1900, *A. S. Hitchcock* 221 (GH); MANATEE CO.: north end of Longboat Key near Long Beach, 15 miles nw of Sarasota, sprawling perennial herb in sand, corolla white with yellow center, Aug. 1, 1950, *R. L. Wilbur* and *G. L. Webster* 2510 (GH); PALM BEACH CO.: north of Palm Beach, suffruticose, 1-2 ft. corolla yellow, April 29, 1920, *Alfred Rehder* 853 (GH); PINELLAS CO.: Fort De Soto Park, Mullet Key, south of Gulfport, beaches north end of key, stems depressed, trailing, occasional, corolla white, Oct. 5, 1963, *O. Lakela* 26527 (GH, USF); SARASOTA CO.: Siesta Key, Anne E. Perkins, Jan. 28, 1943 (GH).

This variety appears to be a maritime ecotype distinguished by its prostrate spreading habit and apparent preference for habitats very near the coast in peninsular Florida where it is apparently endemic.

In addition to the three species cited, two other heliotropes may occur in southern Florida: *H. fruticosum* L. (*H. phyllostachyum* Torr., *H. myosotoides* Chap.) was collected by Blodgett at Key West, and later by Garber and by Palmer. No recent collections have been seen, however. *Heliotropium indicum* L. (*Tiaridium indicum* (L.) Lehm.), a hispid annual native to the Old World may occur in disturbed sites in southern Florida, but apparently it is uncommon.

VERBENACEAE

Lantana

Lantana ovatifolia Britt. is distinguished from other species in southern Florida by its unarmed stems and heads

with bracts not formed into an involucre. Two well-marked varieties occur although the typical one appears to be less common.

Stems erect; leaves up to 9 cm long. ..... var. *ovatifolia*
Stems decumbent or reclining; leaves up to 4 cm long. .. var. *reclinata*

LANTANA OVATIFOLIA var. OVATIFOLIA, Britton in Bull. N. Y. Bot. Gard. 4: 123. 1905.

TYPE: Eight mile Rocks, Grand Bahama, *Britton & Millspaugh* 2450 (NY).

DADE CO.: sand dunes near head of Indian creek, opposite Miami, Nov. 22, 1912, *J. K. Small* 3872 (GH); pinelands, Miami, May 8, 1930, *F. Duckett* (GH); LEE CO.: frequently flowers yellow, shrub 160 cm tall, May 11, 1954, *G. R. Cooley* 2674 (GH); PINELLAS CO.: five miles south of Port Richey, white sandy scrub bordering inlet from Gulf, slash pine, saw palmetto, scrub oaks, Aug. 1960, *J. D. Ray* 9988 (GH, USF).

LANTANA OVATIFOLIA var. **reclinata** R. W. Long, var. nov.

A typo differt ramis prostratis, foliis parvis, plerumque 1-4 cm longis fructu 2.5-3.5 mm longis.

TYPE: FLA. DADE CO.: Fuch's hammock, Homestead, corolla yellow, plant decumbent. *George R. Cooley* 9324, *R. J. Eaton, F. C. Craighead, O. Lakela*, Oct. 14, 1962. In Gray Herbarium, isotype in USF.

L. depressa Small, in Bull. N. Y. Bot. Gard. 3: 436. 1905.

Shrubs with reclining or decumbent stems, leaves mostly 1-4 cm long, elliptic to ovate, serrate, scabrous, pubescent beneath, fruit 2.5-3.5 mm long, pinelands, endemic to southern Florida.

DADE CO.: corolla yellow, leaves dark green above, open field, Homestead, Sept. 17, 1952, *J. Hardin, W. Humphrey, W. Duncan* 14049 (GH); pinelands about Sykes hammock, March 4, 1915, *J. Small* 5667, *C. Mosier, E. Small* (GH); rocky pinelands near Goulds, April 13, 1942, *D. E.* and *M. S. Eyles* 8082 (GH); low calcareous ground, 4 miles sw of Royal Palm hammock, May 22, 1925, *E. Palmer*, (GH); Brickell hammock, Miami, April 27, 1920, *A. Rehder* 811 (A); pinelands, Long Pine Key, common, April 14, 1952, *W. B. Robertson* 156 (GH).

In recognizing this *Lantana* Small noted that to him it differed from *L. camara* L. in producing prostrate unarmed

branches and smaller flowers. The plant appears to be more closely related to the West Indian species *L. ovatifolia* from which it differs chiefly in producing reclining or prostrate branches, smaller leaves and somewhat smaller fruits. It is apparently endemic to a very small portion of extreme southern Florida judging from collections.

RUBIACEAE

Ernodea

In Florida Small distinguished two species, *E. littoralis* Sw. and *E. angusta* Small, the latter separated by its supposedly narrower leaves, smaller flowers, and corolla pink or reddish rather than pinkish-white or white. Experience in the field suggests that the two taxa are connected by intermediates although they apparently are different ecotypes. The typical variety generally occurs in the coastal areas, in sandy or rocky soil, while var. *angusta* is more commonly found inland in pinelands and in drier sites. The two may be keyed as follows:

Leaf-blades linear oblong to elliptic, calyx mostly 7-8 mm long. ..... var. *littoralis*

Leaf-blades linear; calyx mostly 5-6 mm long. ..... var. *angusta*

ERNODEA LITTORALIS var. LITTORALIS Swartz, Prod. Veg. Ind. Oct. 29, 1788.

Corolla usually pinkish-white or white, coastal areas, southern Florida, Florida Keys, and West Indies.

ERNODEA LITTORALIS var. **angusta** (Small) R. W. Long, stat. nov.

E. angusta Small, in Bull. N. Y. Bot. Gard. 3: 438. 1905.

Corolla usually pink or reddish, usually less than 1 cm long, in pinelands, southern Florida Keys, and West Indies.

TYPE: FLORIDA, DADE CO.: in pinelands between Cutler & Camp Longview, Nov. 1903, *Small* 870 and *Carter* (NY).

DADE CO.: open sandy stretch of disturbed hammock and pineland, with remnants of original vegetation north of Post Office, Homestead; fruits shiny, orange, July 19, 1964, *O. Lakela* 27299 (GH, USF); small trailing shrub, flowers red, Coconut Grove, Jan. 26, 1932, *J. G. Jack* (A); open pinelands, limestone outcrop near Rockdale, May 22, 1925, *E. J. Palmer* 27511 (A); *Coconut Grove*, Feb. 3, 1933,

H. O'Neill 8158 (A); MONROE CO.: vicinity of Watson's hammock, edge of pinelands along roadside, scrambling shrub, fruits yellow, March 25, 1958, *W. L. Stern* 304 and *K. L. Chambers* (GH); Big Pine Key, Feb. 4, 1940, *R. J. Seibert* 1289 (A).

The relationship of *Ernodea*, a small genus of the West Indies principally in the Bahamas and Florida, with the Hispaniolan genus *Isidorea* A. Rich ex A. P. DeCandolle is apparent through intermediate species, such as *I. leonardii* Urban and *E. littoralis*. It is probable the two plants are congeneric, but until further field studies are made it is advisable to maintain the genera separately. Generally, the morphological variation of *Isidorea* appears to be broader than *Ernodea*, and could be further broadened to include the latter genus.

Spermacoce

Two species occur in southern Florida, *S. tenuior* var. *floridana* and *S. tetraquetra*. From examination of specimens, it appears doubtful that *S. tenuior* var. *tenuior* is present although it does occur in northern Florida. Our specimens are mostly procumbent or decumbent with small leaves, often 1-2 cm long, annual, and with smooth hypanthia. Typical *S. tenuior* plants have hirsute hypanthia and generally larger, more ovate or elliptic leaves (photo, type GH!). It appears, however, that the two varieties are connected by morphological intermediates. *Spermacoce tetraquetra*, our other species, is a distinctive form because of its generally larger habit, usually erect, and hirsute-white pubescent leaves and stems.

Stems and leaves glabrous or nearly so. .... *S. tenuior* var. *floridana*
Stems and leaves pubescent with whitish hairs. ..... *S. tetraquetra*

SPERMACOCE TENUIOR L. var. **floridana** (Urban) R. W. Long, stat. nov.

Spermacoce floridana Urban, Symb. Ant. 7: 550. 1913.
Spermacoce keyensis Small, Fl. Fla. Keys 141, 155. 1913.
Spermacoce floridana Gandoger, Bull. Soc. Bot. Fr. **65:** 35. 1918.
Spermacoce portoricensis A. Gray, Syn Fl. N. A. I(2): 34. 1884, non Balbis = *Hemidiodia ocimifolia*.

TYPE: in locis apertis arenosis Ins. Key West, Florida austr. *Rugel* 298, Feb. 1846 (isotype, GH!)

DADE CO.: waste ground, Dec. 15, 1902, *A. Fredholm* 5642 (GH); Miami, door yards, *A. H. Curtiss* 1109 (GH); MONROE CO.: hammocks, Key West, March 20, 1915, *J. K. Small* 5990 and *C. A. Mosier* (GH); Key West, Jan. 7, 1892, *J. H. Simpson* 477 (GH); Key West, Aug. 1877, *A. P. Garber* (GH); Key West in umbrosis, Ins. Key West, Florida austr, *Rugel*, Feb. 1846 (cited in original description), (GH).

SPERMACOCE TETRAQUETRA A. Rich.

DADE CO.: hammocks between Miami and Coconut Grove, Nov. 26-Dec. 20, 1913, *J. K. Small* 4667 and *G. K. Small* (GH); Everglades National Park, near Homestead in Miami oolite and solution holes, hammock and pineland association, hirsute hairs whitish, coarse, Oct. 16, 1962, *G. R. Cooley* 9404, *J. Eaton, F. Craighead* and *O. Lakela* (GH); in hammocks between Coconut Grove and Cutler, Nov. 13-23, 1903, *J. K. Small* 1207, *J. Carter* (GH).

CUCURBITACEAE

Melothria

The variation of *Melothria pendula* in Florida is particularly difficult to understand taxonomically. Small described two new species from collections by G. V. Nash, and both of them are obviously closely related to *M. pendula*. Cogniaux described several variants of *M. pendula* in his two monographs. In all instances leaf pubescence and texture, leaf blade and size and shape together with the morphology of the fruiting peduncles and fruit were all considered taxonomically important.

Variation of *M. pendula* in southern Florida is particularly complex. Our common plants are small, rough-leaved forms that can be referred to *M. pendula* var. *aspera*; forms with thick leaves and stout peduncles and large fruits are referrable to var. *crassifolia*; much less commonly found is the typical variety with large, thin, pubescent leaves. At this time it is not possible to identify any ecological differences between the varieties, and all are apparently connected by intermediates. The relationships may be seen in the following key:

1. Leaf blades thin, often 5-8 cm wide, hirtulous. ..... var. *pendula*
1. Leaf blades thicker, often 2-4 cm wide, scabrous or pubescent with thick stout hairs.

2. Leaf blades mostly 2-3 cm wide, very scabrous on both sides, deeply lobed; berries globose. ..... var. *aspera*
2. Leaf blades mostly 3-4 cm wide, rough pubescent, shallowly lobed; berries oblong. ..... var. *crassifolia*

MELOTHRIA PENDULA L. var. PENDULA

JACKSON CO.: vine, branches spreading on the ground and running up trunks of rough-barked trees; flood plain forest along Apalachicola River, w of Chattahoochee, Oct. 17, 1958, *R. K. Godfrey* 57835 (GH); LEE CO.: Ft. Myers, marshes, July-Aug. 1900, *A. S. Hitchcock* 107 (GH); PALM BEACH CO.: Jupiter Island, July 28, 1956, *G. Cooley* 4874, *E. West* and *T. Daggy* (GH).

MELOTHRIA PENDULA var. ASPERA Cogn. in DC. Monog. Phan. 3: 587. 1881. incl. *M. pendula* var. *microcarpa* Cogn. DC. Monog. Phan. 3: 587. 1881.
M. nashii Small, Bull. Torr. Bot. Club 25: 483. 1898.
M. microcarpa Shuttlew. ex Small, Man. S. E. Fl. U. S. 1284. 1933.

CITRUS CO.: sandy soil dominated by herbs, fruit oblong, July 12, 1962, *O. Lakela* 25162 (GH, USF); DADE CO.: glades farm lands south of Long Pine Key, common, April 23, 1952, *W. B. Robertson* 198, (GH); LEE CO.: Sanibel Island, climbing perennial of damp waste places, Feb. 23, 1954, *G. R. Cooley* 2519 (GH); PALM BEACH CO.: Kelsey City, sandy bank along ditch, Dec. 4, 1920, *Fannie Randolph* 116 (GH).

MELOTHRIA PENDULA var. CRASSIFOLIA (Small) Cogn. Pflanzenreich 4, Fam. 275, I: 88, 1916.
Melothria crassifolia Small, Bull. Torr. Bot. Club. 25: 483. 1898.

TYPE: LAKE CO.: collected in vicinity of Eustis, stems creeping on ground, moist soil, June 1-15, 1894, *G. V. Nash* (isotype, GH!).

COLLIER CO.: north of Deep Lake, route 29, Canal bank, and margin of hammock w side of the road, Oct. 1962 *G. Cooley* 9382 (GH, USF); DADE CO.: Cape Sable, April 13, 1923, *A. Harris* C23352 (GH); MANATEE CO.: ad ostia fl. Manatee, Florida, austr. occ. June 1845 legit *Rugel* 260.

ASTERACEAE

Kuhnia

Examination of herbarium and field collections leads me to conclude that *K. mosieri* is another geographic variety

of the widespread *K. eupatorioides*, and is closely related to *K. eupatorioides* var. *pyramidalis* Raf. The southern Florida population is narrowly endemic to Dade County; Shinner's (1946) citation of a Chapman specimen from Aspalaga, Fla. is apparently an error, and the plant in question is referrable to var. *pyramidalis*.

KUHNIA EUPATORIOIDES L. var. **floridana** R. W. Long, var. nov.

A typo differt foliis linearibus, minus quam 3 mm latis, plerumque minus quam 3 cm longis.

TYPE: DADE CO.: Miami, Florida, May 13, 1904, *S. M. Tracy* 9046. In Gray Herbarium.

Stems simple, up to 7 dm tall, leaves linear to less commonly oblong-entire, scabrous-pubescent above, densely resin-dotted beneath, larger blades 2-4 cm long, 1-3 mm wide, the upper leaves gradually becoming smaller. Inflorescence corymbose or corymbose-paniculate; involucres 8.5-10.5 mm high, florets 9-13, corollas 6-6.5 mm long, achenes 3.5-4.5 mm long.

Kuhnia mosieri Small, Man. S. E. Fl. 1329 and 1508, 1933.

Two names, *K. eupatorioides* var. *gracilis* T. & G. and *K. paniculata* Cass. have been applied incorrectly to slender forms of *K. eupatorioides* var. *pyramidalis* and to *K. eupatorioides* var. *floridana*.

DADE CO.: rocky pinelands between Bay Biscayne and the Everglades, *A. H. Curtiss* 1187 (GH); open grassy area, near intersection of Redlands and 308th St., Homestead, frequent in unbroken ground, Aug. 10, 1963, *O. Lakela* 26137 (USF); Sunset Dr. and SW 71 Ct., Miami, vacant lot, pineland, sandy soil, S26, T54S, R40E, Sept. 5, 1968, *G. Avery* 459 (USF).

Aster

The genus is represented in southern Florida by nine species. Small described a number of new species from this area, but examination of collections has required some nomenclatural changes.

ASTER CONCOLOR L. var. **simulatus** (Small) R. W. Long, stat. nov.

Aster simulatus Small, Bull. Torr. Bot. Club **51:** 388. 1924.

TYPE: DADE CO., FLA., Silver Palm Schoolhouse, Nov. 26, 1913, *J. K. Small* in NY Herbarium.

Small stated that this plant is related to *A. concolor* but differed by having upper leaf-blades scale-like, smaller, and more copiously puberulent bracts and involucres; *A. concolor* var. *concolor* has leaves ovate-lanceolate to lanceolate and stems silky pubescent.

BROWARD CO.: pinelands w of Haledale, Dec. 16, 1923, *J. Small* 11090, *J. B. DeWinkeler*, and *C. Mosier* (GH); DUVAL CO.: dry pine barrens near Jacksonville, Dec. 1, 1898, *A. H. Curtiss* 6434; HILLSBOROUGH CO.: ca. 1 m ne of Fletcher Ave., and Morris Bridge Rd, in fencerow, Dec. 2, 1962, *O. Lakela* 25598 (GH, USF); ORANGE CO.: dry woods, Winter Park, May 19, 1927, *F. W. Hunnewell* 10,533 (GH).

ASTER PATENS Ait. var. **floridanus** R. W. Long, var. nov.

A typo differt caulibus et foliis scabris; capitulo circa 2 cm latis.

TYPE: COLLIER CO., FLA., abundant on pine and cabbage palm islands in Big Cypress, Brown Lake, 15 mi south of Immokalee; 60-80 cm high; leaves scabrous, heads about 2 cm diameter, showy, rays pale violet, Dec. 12, 1945, *L. J. Brass*, 15780. In Gray Herbarium.

Aster fontinalis Alexander ex Small, Man. S. E. Flora 1382. 1933.

This variety is definitely related to *Aster patens*, but it represents a race that is endemic to peninsular Florida. It is separable from the typical form on the basis of scabrous stems and leaves, and larger heads.

FLAGLER CO.: west of Bunnell, tall branching, Nov. 30, 1943, *Oakes Ames* 410 (GH); near Bunnell, rays deep lilac, Nov. 30, 1943, *Oakes Ames* 406 (GH); LEON CO.: open old field pine woods, 2 mi e of Tallahassee, Nov. 4, 1955, *R. K. Godfrey* 54305 (GH); MADISON CO.: disturbed roadside sands bordering long leaf pine turkey oak woods, 4 mi w of Madison, April, 1957, *R. Kral* 4590 (GH).

ASTER TENUIFOLIUS L. var. **aphyllus** R. W. Long, var. nov.

A typo differt foliis linearibus ad subulilinearibus, deminutiis vel destitutis super; caulibus tenuibus.

TYPE: HILLSBOROUGH CO., Florida, northwest of Tampa,

south of State Route 580 and west of Rocky Creek, Dec. 24, 1962, *O. Lakela* 25610. In Gray Herbarium, isotype in USF.

A. bracei Britton ex Small, Fl. Miami 190, 1913, type, New Providence, *Britton and Brace* 394, in NY.

This variety resembles *A. tenuifolius* var. *tenuifolius* (photo, GH!) in producing stolons, in general habit, and in ecological preferences. It differs in producing smaller, much reduced linear or linear-subulate leaves that are apparently absent in upper stems; it also has smaller heads. Both varieties, however, are connected by intermediate forms. Apparently *A. tenuifolius* var. *aphyllus* represents a West Indian-Florida population segregate of the more northern *A. tenuifolius*.

BAHAMAS: Eleuthera, palmetto-land near airstrip ca 2.5 miles n of Rock Sound, 76 degrees 10 min W, 25 degrees, 52 min N common; rays white or pink, July 27, 1960, *G. Webster* and *T. Williams* 10719 (GH); Grand Bahama Island, July 1904, *G. Allen* 17 (GH); New Providence, pine barrens, in bogs, Feb. 28, 1888, *Eggers* 4311 (GH); New Providence, saline rocky flats, near Nassau, Feb. 18, 1903, *A. H. Curtiss* 84.

FLORIDA: COLLIER CO.: plentiful on pine and cabbage palm islands in Big Cypress, erect 30-70 cm, leaves somewhat fleshy, heads little more than 1 cm diam, Brown Lake 15 mi s of Immokalee, Dec. 12, 1945, *L. J. Brass* 15775; HILLSBOROUGH CO.: about 6 mi se of Tampa, weedy waste flat formerly in longleaf pine-cabbage palmetto, Oct. 28, 1960, *J. D. Ray* 10573 (intermediate to typical var.); MONROE CO.: Big Pine Key, Feb. 26, 1936, *E. P. Killip* 31621; DADE CO.: sand dunes near head of Indian Creek, opposite Miami, Nov. 22, 1912, *J. K. Small* 3879 (GH); PINELLAS CO.: sandflats near Pasadena Golf Course, Gulfport, Dec. 21-28, 1949, *R. F. Thorne* 9401 (GH); WAKULLA CO.: brackish marsh, St. Marks Wildlife Refuge, Oct. 6, 1955, *R. Kral* and *R. Godfrey* 54084.

ASTER DUMOSUS var. SUBULAEFOLIUS T. & G., Fl. N. A. 2: 128. 1841, incl. *A. simmondsii*, Small Fl. Miami 190, 200. 1913.

A. sulznerae, Small, Fl. Miami 190. 1913.

A. dumosus var. *gracilipes* Wiegand, Rhodora 30: 166. 1928.

Small's two species represent mixtures of smallish, stiff, linear-leaved forms, and larger more lax-leafy forms, judging from his annotations. The former may be referred to

A. dumosus var. *subulaefolius* for which specimens are cited below. The latter, occurring less commonly in southern Florida, may be referred to *A. dumosus* var. *coridifolius* (Michx.) T. & G.

DADE CO.: Everglades w of Peters, Nov. 20, 1916, *J. K. Small* 7922, (GH); New River canal beyond head of New River, Nov. 11-25, 1913, *J. Small* 4431 and *G. Small* (GH); Royal Palm hammock, Feb. 20, 1915, *J. K. Small* 5428 and *E. Small* (GH); Deering Snapper Creek hammock, Dec. 10, 1919, *J. Small et. al.* (GH); VOLUSIA CO.: 1 mi w of Ormond, in open field, Nov. 23, 1943, *Oakes Ames* 11 (GH).

Flaveria

The evidence for considering *F. latifolia* as representing stabilized diploid hybrids in southern Florida has been presented elsewhere (Long & Rhamstine, 1968). The correct citation for the hybrid was not given, however, and is given here for validation.

FLAVERIA × LATIFOLIA (J. R. Johnston) Rydb. (pro sp.)
(F. floridana × F. linearis)
F. linearis var. *latifolia* J. R. Johnston, Proc. Amer. Acad. Arts Sci. 39: 289. 1903, (pro parte, including the type).
F. latifolia (J. R. Johnston) Rydb. North Amer. Flora 34: 145. 1915. (pro parte).

Heterotheca

The transfer of *Chrysopsis* to *Heterotheca* (cf. Shinners, 1951; Wagenknecht, 1960) requires a number of new combinations and nomenclatural revisions in Florida species.

HETEROTHECA **hyssopifolia** (Nutt.) R. W. Long, comb. nov.
Chrysopsis hyssopifolia Nutt., Jour. Acad. Natural Sciences, Phil. 7: 67. 1834.

The species was described by Nuttall from a specimen collected in "West Florida" as smooth with narrow or linear leaves. The specimens from southern Florida are not so leafy as the northern and west Florida plants, but otherwise they are very similar.

BAY CO.: coarse sand, scrub oak barren, Tyndall Field, Military Reservation, Oct. 15, 1955, *R. K. Godfrey* 54182 and *R. Kral* (GH); GULF CO.: Apalachicola, Chapman Herb. 1959, dry pine barrens,

Sept. 18, 1895; HARDEE CO.: common on dry prairie; apex of bracts often purplish; rays and disk yellow, about 3 mi e of Zolfo Springs, July 23, 1949, *L. J. Brass* 20613 (a good example of the south Florida race) (GH); HERNANDO CO.: scrub-oak and sand ridge, 4.5 mi n of Brooksville, Oct. 16, 1950, *R. K. Godfrey* 50858 (GH); INDIAN RIVER CO.: dry pine barrens, *A. H. Curtiss* 1364 (GH); dry pine barrens, Melbourne, Aug. 3, 1896, *A. H. Curtiss* 5736.

HETEROTHECA HYSSOPIFOLIA (Nutt.) R. W. Long var. **subulata** (Small) R. W. Long, stat. and comb. nov.

Chrysopsis subulata Small, Man. Fl. S.E. U.S. 1338. 1933.

TYPE: between Avon Park and Sebring, Florida, *J. K. Small* 11495, in NY Herb.

The variety is similar to the typical one except the bracts of the involucre are prolonged and have conspicuous, curved, or bent, caudate tips. The leaf blades are somewhat broader than the typical plant, but they are very similar otherwise. Apparently *H. hyssopifolia* var. *subulata* is another of the endemic races of central Florida, although specimens may be found farther north and south in the state.

FRANKLIN CO.: pine savannah ¼ mi south of Ochlockonee River by U. S. 319, T 6S, 3W, Sec. 2, Oct. 3, 1954, *J. B. Morrill* and *R. K. Godfrey* (GH); HIGHLANDS CO.: scrub between Avon Park and Sebring, July 17, 1924, *J. K. Small, J. W. Small,* and *J. DeWinkeler,* (topotype) (GH); INDIAN RIVER CO.: dry pine barrens near Eau Gallie, *A. H. Curtiss* 1364; ORANGE CO.: dry pine barrens, July 7, 1902, *A. Fredholm* 5356; POLK CO.: pine palmetto flatwoods, near the southern end of Crooked Lake, Aug. 3, 1955, *R. K. Godfrey* 53835 and *R. Kral* (GH).

HETEROTHECA GRAMINIFOLIA (Michx.) Shinners, var. **traceyi** (Small) R. W. Long, stat. and comb. nov.

Chrysopsis traceyi Small, Fl. S. E. U. S. 1182, 1339. 1903.

TYPE: Tracy, Pls. Gulf St. 7713. In herb. NY.

This variety is distinguished by its longer ray flowers that are about 1 cm long, and by lower leaf blades that are much elongated. Otherwise, it is similar to the typical variety; *H. graminifolia* var. *traceyi* is endemic to peninsular Florida, especially southern Florida.

COLLIER CO.: Big Cypress, 6 mi w of Miles City, frequent on low pinelands, leaves silvery, flower heads up to 3.5 cm in diam, florets a rich yellow, Jan. 14, 1946, *L. J. Brass* 15883 (GH); DADE CO.: Krome hammock near Homestead, April 11, 1924, *J. K. Small* 11,162,

J. DeWinkeler, C. Mosier, (GH); FLAGLER CO.: south of Bunnell on Route 4, on banks of railroad ditch in full sun, heads up to 3.5 cm across, all plant prevalently dwarf, Dec. 6, 1943, *Oakes Ames* 233; MONROE CO.: Big Pine Key, rays bright yellow, 6-10 mm long, pine-palm woods northeast of Inn, Nov. 25, 1951, *E. P. Killip* 41459 (GH).

HETEROTHECA **floridana** (Small) R. W. Long, comb. nov.

Chrysopsis floridana Small, Fl. S. E. U. S. 1183, 1339. 1903.

Chrysopsis mariana var. *floridana* (Small) Fern. Rhodora **39**: 455. 1937.

TYPE, Pl. Gulf St. Tracy 7344, Bradenton, Fla. In NY herb. Isotype GH!

This is a distinctive species with heavy pubescence, tomentose leaves that are spatulate near the base and ovate to ovate-lanceolate near the top of the stem. It is endemic to Florida, apparently to the lower Gulf coast and presumably in southwestern Florida. The species appears to be related to *H. scabrella* T. & G. but since so few collections have been made, it is not possible to place the taxon definitely in relation to other species of the genus.

HILLSBOROUGH CO.: near Ruskin, in openings of white sand in scrub oaks and *Ceratiola,* low flat terrace south of Little Manatee River Bridge, rays golden yellow, glandular on phyllaries and peduncles. Plants suffrutescent, perennial, Nov. 11, 1961, *O. Lakela* 24826 (GH, USF).

Cirsium

Cirsium vittatum was described by Small as differing from *C. pinetorum* (= *C. horridulum* Michx.) in having narrow, elongated, basal leaf blades which are not pinnatifid, and anthers twice as long as the filaments. The plants are often smaller than the typical variety, and are endemic to southern Florida. Although corollas are usually cream-colored or yellowish, they may be purplish. The two races apparently hybridize and intergrade freely, and may occur together in the same area. A third taxon, *C. nuttallii* (DC.) A. Gray, morphologically distinct with heads not involucrate, also occurs in southern Florida.

CIRSIUM HORRIDULUM Michx. var. HORRIDULUM
Cirsium smallii Britton, Britt. & Millsp. Bahama Fl. 458, 1930.
Carduus smallii (Britt.) Ahles, Jour. Elisha Mitchell. Sci. Soc. **90**: 173. 1964.

DADE CO.: southwest of Homestead, Everglades National Park, common throughout, Mar. 30, 1963, *O. Lakela* 25736 (leaves heavily tomentose) (USF); HILLSBOROUGH CO.: seasonally wet pineland & palmetto 2.4 m nw of Trout Creek, April 17, 1964, *O. Lakela* 27156 and *A. Burdette* (USF); MONROE CO.: Big Pine Key, common in flat pinelands, growing with *C. vittatum*, Nov. 13, 1964, *O. Lakela* 27897 (USF); PINELLAS CO.: cleared roadside largely of white sand, Jct. US 19, and Fla 52, May 23, 1963, *O. Lakela* 26015 (USF).

CIRSIUM HORRIDULUM var. **vittatum** (Small) R. W. Long, stat. and comb. nov.
Carduus vittatum Small, Bull. N. Y. Bot. Gard. **3**: 439. 1905.
Cirsium vittatum Small, Man Fl. S. E. U. S. 1483. 1933.

COLLIER CO.: Big Cypress, Fahkahatchee, south of Miles City, glade and cypress margin, Mar. 6, 1965. *O. Lakela* 28197 and *R. W. Long* (intermediate between *C. horridulum* and *C. vittatum*) (USF); MONROE CO.: Big Pine Key, Watson's hammock and surrounding pineland, Aug. 6. 1966, *R. W. Long* 2099 (USF); Everglades National Park, near Homestead, *G. R. Cooley* 9419, *et. al.* Oct. 16, 1962 (GH); Everglades National Park, southwest of Homestead, outcrops of oolite, common, Mar. 30, 1963, *O. Lakela* 25720 (USF).

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NOTES FROM THE PRINGLE HERBARIUM III

F. C. SEYMOUR

In the second installment of Notes from the Pringle Herbarium (Rhodora **69**: 377-380. 1967), reference was made to "other names left for subsequent mention." Some of these are recorded here.

1. **Potamogeton Berchtoldii** Fieber var. **lacunatus** (Hagström) Fern. Growing in stagnant water, 25 June 1966, Alpine Heights, Warren, Vermont, *Frank C. Seymour* 23,883 (VT). This variety, rather infrequent at best, appears to be new to Vermont. The name, Alpine Heights, though rather pretentious, seems well justified. Near by, at the water's edge was *Carex canescens* L. var. *canescens*, (*Seymour* 23,744) (Seymour Herbarium) a species which M. L. Fernald (Gray's Man. ed. 8, p. 313) describes as "circumboreal." Not far away (1/4 mile) is a station where *Listera auriculata* Wieg. has been collected.

2. **Anthoxanthum odoratum** L. f. **giganteum** P. Junge was growing in a sugarbush in Jericho, Vermont, 15 Aug. 1968, *George B. Keiser & Frank C. Seymour* 27,058 (VT). This form, growing side by side with f. *odoratum* (*Seymour* 27,056, (VT)), presented such a striking contrast that they seemed like different species.

3. **Bromus racemosus** L. This species, so far as I can ascertain, was first collected in Vermont by Cyrus G. Pringle in 1880 in Charlotte. Prof. William D. Countryman has recently found it in Vernon, Vt. It was a surprise to find it, not by a roadside, but far from any road near Lake Bomoseen in Castleton on 14 June 1968, on a field trip of the Vermont Botanical and Bird Club (*Seymour* 20,901 (VT)). It was among fragments of slaty rock with *Potentilla arguta* Pursh near a trail where many hikers have passed by. It seems rare enough to mention.

4. **Eragrostis multicaulis** Steudel, growing along a roadside, 15 Aug. 1968, in Jericho, Vermont, *Frank C. Seymour & George B. Keiser* 27,054 (VT). This grass has become a

very common roadside weed in some parts of New England but has not been reported previously from Vermont.

5. **Panicum dichotomiflorum** Michx. Spreading from some locality of its earliest establishment in this country, another weed has reached Vermont. Two varieties, var. *dichotomiflorum* and var. *geniculatum* (Wood) Fern., were growing near together at the border of a parking lot and along a walk on the campus of the University of Vermont. There is nothing surprising about this collection except that neither variety was known before in Vermont. Var. *dichotomiflorum*: Burlington, Vt., 30 Aug. 1968, *Seymour* 27,085 (VT) and 18 Sept. 1968, *Seymour* 27,269 (VT). Var. *geniculatum*: same date and place as the last, *Seymour* 27,270 (VT).

6. **Eleocharis tenuis** (Willd.) Schultes. That this has not been reported previously from Vermont seems strange. It was found growing on the shore of Hardwick Pond in Hardwick, Vt., 13 Aug. 1966, *Frank C. Seymour* (24,513) and *Susan C. Gates* (Seymour Herbarium). Nearby in the water was found an abundance of another unusual species, *Potamogeton pectinatus* L., Sago. Although there are a number of other localities in Vermont where the latter has been found, this writer considers it quite uncommon.

7. **Eleocharis nitida** Fern. On a collecting trip when Mr. Charles E. Nichols was the delightful host, he drew special attention to an *Eleocharis* which looked unusual because of its capillary stems. It proves to be *Eleocharis nitida* Fernald from Enosburg, Vermont, *Seymour & Nichols* 26,503 (Seymour Herbarium). Dr. Henry K. Svenson has very kindly verified the identification, commenting "I believe it is new for Vermont."

8. **Orchis spectabilis** L. f. **Willeyi** forma nova, labio roseo. TYPE: St. Johnsbury, Vt., 23 May 1968, *Herman D. Willey, s. n.* (VT). Named in recognition of its collector, Herman D. Willey. M. L. Fernald in Gray's Man. ed. 8, p. 468, mentions that the lip may be "rarely pink", but he does not give it a name. Mr. Willey sent to the Pringle Herbarium a beautiful transparency of the form with pink lip taken on

June 11, 1967. The next year he very kindly sent the specimen, which is the type. Mr. Willey writes that he has been watching this form for several years and that the several plants continue constantly to have pink lips.

9. **Salix cordata** Michx. is a name not new to Vermont botany. E. J. Dole in the 3rd. ed. of the Flora of Vermont, published in 1937, lists *S. cordata* Michx. but omits *Salix rigida* Muhl. Not only formerly were these two considered to be one species but still there is much doubt as to whether they are distinct. Since *S. cordata* differs more from typical *Salix rigida* than does *Salix rigida* var. *angustata* (Pursh) Fern., there is good reason to treat them as distinct. To distinguish these two species, see the clear description by M. L. Fernald in Rhodora 48: 33. 1946. Doubtless because *S. rigida* Muhl. was considered to be a synonym of *Salix cordata* Michx. (not *S. cordata* Muhl.), specimens of *Salix cordata* Michx. occurring in Vermont have not been reported. The following specimens from Vermont in the Pringle Herbarium belong in *S. cordata* Michx. Burlington, 24 July 1940, *L. A. Charette* 316; Leicester, 19 Sept. 1909, *D. Lewis Dutton, s. n.*; specimen without definite locality but probably collected in Middletown Springs, Vt., 4 May and 21 July 1902, *Dana S. Carpenter.* Var. *abrasa* Fern., also has been found in Roxbury, 2 Oct. 1968, *Margaret F. Clark* (VT).

10. **Salix ridida** Muhl. var. **angustata** (Pursh) Fern. Collected in Vt., Waterville, 1 June 1966, *Seymour* 23,801 (Seymour Herbarium). This also has not been reported previously from this state.

11. **Salix** × **subsericea** (Andersson) Schneider has been found previously in Brandon, Vermont. A specimen which this writer believes is this hybrid was collected by him in Eden, Vt., at Eden Pond, 24 Sept. 1966, *Seymour* 25,250 (Seymour Herbarium).

12. **Polygonum Persicaria** L. var. **ruderale** (Salisb.) Meisner. How could a plant appeal more eloquently for recognition than did this plant, growing right in the crevices of the cement walk in front of the Pringle Herbarium? There

were a number of specimens which persisted up to the time of frost in 1968. The first collection was made on 15 Oct. 1967 (Seymour Herbarium). A few more specimens (*Seymour* 27,083, (VT)) were taken on 29 Aug. 1968. This author finds no earlier specimens or records of its presence in Vermont.

13. **Lupinus polyphyllus** Lindley. Roberta G. Poland (Mrs. Burdette) discovered a colony on the lower levels near the trail of Monadnock Mt., in Lemington, Vermont, on 24 June 1967. She collected a few specimens, one of which is in the Pringle Herbarium. On visiting the spot a few days later, the writer found many plants growing tall and rank. This plant, indigenous in northwest America, is well established in Lemington.

14. **Pycnanthemum tenuifolium** Schrader var. **Laurencei** varietas nova, foliis similibus Pycnanthemo tenuifolio Schrader sed caule copiose pubescente. TYPE: Massachusetts, Acton, 28 July 1966, *Laurence E. Richardson* (VT). A specimen very kindly given me by Mr. Laurence E. Richardson bears a strong resemblance to *Pycnanthemum pilosum* Nutt. in its densely hairy stem. However, the leaves are very narrow, the widest only 3 mm wide as in *P. tenuifolium*. In typical *Pycnanthemum tenuifolium* the stems are glabrous. That it is a hybrid of *P. pilosum* is unlikely in as much as *P. pilosum* is not known east of southern Michigan. Therefore I designate it as a new variety in honor of the collector Laurence E. Richardson.

15. **Sonchus uliginosus** Bieb. On the same trip with George B. Keiser mentioned above, a *Sonchus* growing by the roadside in Essex, Vermont, 15 Aug. 1968, attracted my attention. Whether *Sonchus uliginosus* Bieb. had previously been found in Vermont I did not know until I returned to the Herbarium. These specimens, *Seymour & Keiser* 27,025 (VT), appear to be the only ones from Vermont.

Specimens of these collections, in cases in which there is a duplicate, are being given to the New England Botanical Club.

PRINGLE HERBARIUM
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INFRASPECIFIC CLASSIFICATION IN THE CAROLINA FLORA

ROBERT L. WILBUR*

The taxonomic treatment of infraspecific variation is one of the more troublesome problems confronting the systematic botanist. Judging from numerous recent articles concerned with this subject, the topic is no less controversial among zoologists nor is it apparently any closer to satisfactory resolution. For example, Wilson and Brown (Syst. Zoo. 2: 100., 1953) "are convinced that the subspecies concept is the most critical and disorderly area of modern systematic theory — more so than taxonomists have realized or theorists have admitted."

A comparison of the infraspecific taxa recognized in two recently completed floras of temperate North America will emphasize something of the diversity in current taxonomic practice. Steyermark (1963) recognized 517 subspecies or varieties within Missouri and an additional 297 forms. Radford *et al.* (1968) included 174 subspecies or varieties within North and South Carolina but no forms. The Carolinas possess a total of 3360 recognized species compared to 2438 known from Missouri. Although the Carolinas together have an area approximately one fifth larger than Missouri, their greater number of species is perhaps better attributed to their greater diversity in topography, geology, climate and ecology than exists in Missouri. There is a ratio in the Carolina Flora of 18.7 species to every subspecies or variety recognized while the Missouri Flora has only 4.7 times as many species as it has subspecies or varieties. If one included all infraspecific taxa recognized in Steyermark's Missouri flora, there is an accepted subspecies, variety or form for every three species included. It is safe to conclude that the greater richness of the Missouri flora in

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recognized infraspecific taxa in comparison to that of the Carolinas is due more to the difference in taxonomic outlook of the respective authors than it is to differences in the frequency of infraspecific variation within the two areas. It would not appear that either of the two taxonomic publications is exceptional in their treatment of infraspecific variation but merely illustrate something of the diversity existing in current taxonomic practice. As has been suggested elsewhere (Wilbur, 1968), greater effort should be made towards achieving a greater degree of uniformity by taxonomists before such major works as the projected Flora North America and Flora Neotropica are prepared.

Three infraspecific categories are most frequently encountered in botanical taxonomic literature: subspecies, variety and form. It is no more possible to define the proper use of each of these taxonomic ranks than it would be to summarize completely the great diversity in current taxonomic usage. The following statements perhaps sketchily outline the principal trends in botanical practice.

1) infraspecific taxa are incipient species and the taxonomist can and should utilize the hierarchy of *subspecies*, *varietas*, and *forma* to present an estimate of how far the population has diverged towards the status of species.

2) it is futile to attempt categorizing the great array of variation encountered within most wide-ranging species, hence, one should restrict oneself to naming formally only recognizable populations occupying either different geographic areas or ecological sites.

a) Since the category variety has been applied to so many different kinds of variation from slight genetical variant, or even habitat modifications to the morphologically distinctive representative of the species in a major geographic and/or ecologic area, its continued scientific use is rendered undesirable since it is too imprecise. Consequently one should designate these geographically and/or ecologically recognizable units as subspecies — a practice

which also has the added virtue of being in closer accord with the prevailing zoological procedure.

b) The category variety ought to be employed for these geographically and/or ecologically recognizable units since it has been historically far more frequently employed botanically. Consequently the necessary bibliographic and nomenclatural paperwork would be reduced to a minimum in contrast to the numerous changes required if one were to adopt subspecies — a category whose botanical usage has been just as varied and imprecise as variety.

3) Both subspecies and varieties are useful infraspecific categories for geographically and/or ecologically distinctive populations with the category subspecies employed for particularly distinctive taxa while variety is to be applied to those somewhat less strongly delimited or, perhaps less subjectively, the subspecies might be employed as a collective taxon for a group of varieties apparently more closely related to each other than to another variety or a group of varieties within the same species.

It would appear that the taxonomic category *forma* has undergone a sharp decline in botanical esteem and as a result there are far fewer minor variants such as color forms of flowers named in recent years than was the custom three or four decades ago. Taxonomists doubtless have wisely concluded that their task is overwhelming enough if they limit themselves to categorizing populations and disregard the sporadic, although often conspicuous, individual variations. Consequently one should not be disappointed that the various authors of the Carolina Manual did not emulate the author of the Flora of Missouri in naming *formae*.

Certainly most taxonomists would agree that if a hierarchy of infraspecific taxa is utilized then the ranks employed should indicate degrees of divergence in the named populations. It is illogical to call apparently equivalent populations *subspecies* in one genus and *varietas* in another.

Yet this easy going practice is openly acknowledged by Munz (1959) in the preface of his "A California Flora." The Carolina Manual apparently follows the same practice since subspecies are recognized only in those few genera (e.g. *Nuphar*, *Hydrangea*, *Acer*, *Asclepias*, and *Phlox*) in which the monographer, whose work was adopted, employed that category rather than variety (or rarely used both). The category *subspecies* as the sole infraspecific unit is far less frequently encountered in the literature of eastern North American botany than it is in the West but, unfortunately, that nomenclatural blight is spreading eastward with increasing momentum.

Although doubtless not a precise standard of measurement compared to those employed by the Newtonian physicists, the "biological species concept" has introduced a useful level of objectivity in helping taxonomists to delimit species in sexually reproducing organisms. One might also hope that eventually the infraspecific categories might convey a more uniform indication of similar biological significance. A small sample of the *varietas* recognized within the Carolina Flora will, I believe, disillusion anyone as to the biological meaningfulness of the category as employed. There, varieties are an extremely heterogenous assemblage. I would like to discuss some of them under the following headings.

1) In some cases the recognized varieties should not be recognized formally as they are either trivial genetical variants, modifications perhaps due to habitat or portions or a morphological continuum.

2) Other varieties are accepted or proposed which give evidence of being better considered as biological species.

3) And there are species possessing morphologically recognizable populations with distinct geographical ranges which are treated as taxonomically indivisable.

1. EXAMPLES OF VARIETIES LACKING TAXONOMIC MERIT.

a) *Monotropsis odorata* var. *lehmaniae* (Burnham) Ahles, Jour. Elisha Mitchell Sci. Soc. **80**: 172. 1964. (Manual, p. 797)

Baldwin's own observations (Rhodora 59: 259-262. 1957) coupled with the detailed study of Wolf (Amer. Midl. Nat. 8: 104-187. 1922) has, as summarized by Wood (Jour. Arnold Arb. 42: 65. 1961), "effectively disposed of *M. lehmaniae* Burnham as the immature fall phase of *M. odorata*". To my knowledge nothing has been published to refute the conclusions reached in the above papers. If new and contradictory knowledge is available, its publication would be of far greater biological interest than the reduction from specific to varietal status of what apparently has been shown to be the fall stage of growth of the spring flowering *Monotropsis odorata*. The striking fragrance of the flowers is detected only at anthesis in the spring and all other differences suggested as distinguishing the supposed two taxa are apparently equally transitional or ephemeral including the differences in the proportions of corolla tube and lobes. Ahles states in the Manual (p. 797) that *M. odorata* var. *odorata* flowers in February through April in the Carolinas and fruits in May and June. The var. *lehmaniae* flowers in the fall from September into November and is said to fruit in October and November. The supposedly diagnostic features employed by Ahles in the Manual are set forth as follows:

Leaves yellowish to tawny, chaffy; flowers fragrant ..... var. *odorata*.

Leaves purplish or lavender, fleshy; flowers not fragrant ..... var. *lehmaniae*.

In the Carolina Manual (p. 795) only the typical element is mapped but maps of both are presented in the Atlas (Radford *et al.* p. 88. 1965).

b) *Calycanthus floridus* var. *laevigatus* (Willd.) T. & G. (Manual, p. 476).

Nicely concluded (Castanea 30: 67. 1965) that within *C. floridus* there exist "two populations, or varieties, which are more or less distinguishable by the glabrous or pubescent undersurface of the leaf" with "each having a more or less distinct geographical range." His map (p. 70) shows a considerable overlapping range of plants with or without

pubescence. Personal observations and Niceley's own admission that both the twigs and leaf undersurface of var. *laevigatus* could be slightly pubescent would suggest that the two are at least not "ideal" varieties. Populations admittedly exist in which "both extremes of pubescence as well as various intermediates are present." It would appear that the differences were of a slight genetical basis and the taxonomic utility of recognizing such as taxa on the basis of existing knowledge seems highly questionable. It seems unlikely that we are concerned here with biologically distinctive populations. Instead the pubescence types are apparently no more deserving of taxonomic recognition than the striking glaucous form of *Fothergilla major* L. (sometimes segregated as *F. monticola* Ashe) or the non-glaucous form of *Zenobia pulverulenta* (Bartr. ex Willd.) Pollard (formerly often designated *Z. cassinefolia* (Vent.) Pollard), which now are both rightfully not allotted taxonomic recognition.

c) *Clethra alnifolia* var. *tomentosa* (Lam.) Michx. (Manual, p. 793).

A recent study (Jour. Elisha Mitchell Sci. Soc. 83: 82-88. 1967) demonstrated, at least to my satisfaction, that "there seems no basis whatsoever to recognize taxa of any rank" within *C. alnifolia*. The variation in amount of pubescence on the abaxial leaf surface ranges from glabrate or sparingly strigillose along the principal veins to so copiously stellate-tomentose that the lower epidermis is masked from view. That study also indicated that the reputed differences in pubescence of style, capsule size and orientation and shape of sepals which in the past had been thought to be correlated with the striking difference in foliar pubescence were either not diagnostic or based upon faulty observations. The extremes of variation are so striking that it is not surprising to find taxonomists disinclined to submerge the tomentose individuals with the more abundant sparingly strigillose types. There seems, however, to be no biologically meaningful criteria by which the pubescence types can be recognized as separate taxa. There is an earlier

varietal name, *C. alnifolia* var. *pubescens* Ait., which should be employed by those who wish to persist in naming segments of a continuum.

2. EXAMPLES OF VARIETIES BETTER TREATED AS SPECIES.

a) *Sabatia dodecandra* (L.) B.S.P. (Manual, pp. 838-839).

Ahles (Jour. Elisha Mitchell Sci. Soc. **80**: 173. 1964) reduced to varietal status without discussion the very distinctive *Sabatia kennedyana* Fern. (= *S. dodecandra* var. *kennedyana* (Fern.) Ahles) and *S. bartramii* Wilbur (= *S. dodecandra* var. *coriacea* (Ell.) Ahles). Ahles also placed *S. harperi* Small, a synonym of *S. foliosa* Fern., in the synonymy of *S. dodecandra* var. *dodecandra*. Four taxa of which three were considered species in the most recent monograph of the genus (Rhodora **57**: 1-23, 43-71, 78-104. 1955) were consequently reduced by Ahles to three varieties of a single species. It now appears probable that I erred in reducing *S. foliosa* to varietal status since it differs from *S. dodecandra* morphologically and possesses a distinctive range and a very different habitat. Perry's studies (1967) suggest that the chromosome number of the two taxa (*S. dodecandra s.s.* and *S. foliosa*) differs as well. Consequently I now believe all current evidence would favor the recognition of four species in this complex and not three as I recognized in 1955 and certainly not one species and three varieties as Ahles suggests. *Sabatia bartramii* and *S. foliosa* are largely sympatric but natural hybrids are unknown. They differ greatly both morphologically and apparently ecologically. Perry's extremely thorough work has shown that their chromosome numbers differ and that artificial crosses between the two result in vigorous but sterile progeny. These facts are certainly more suggestive of specific than varietal status. *Sabatia dodecandra s.s.* is a plant of brackish marshes from Connecticut as far south at least as North Carolina while *S. kennedyana* is a plant of open stream banks and margins of fresh water ponds with a three-parted, disjunct range: 1) Nova Scotia, 2) Massachusetts and Rhode Island, and 3) North Carolina and northeastern South Carolina. Morphologically the two seem

readily distinguishable. Natural hybrids are unknown. Again Perry has shown that the two taxa differ in chromosome number and that their artificially produced progeny are sterile. To treat as does Ahles four taxa such as these as three varieties of a single species obscures their biological or evolutionary divergence.

b) *Utricularia inflata* var. *minor* (L.) Chapm. (Manual, p. 969).

The parenthetical inclusion of Linnaeus in the above trinominal is an error, for Linnaeus' taxon is a very different species; Chapman's varietal name was new and not a transfer. Reinert and Godfrey (Amer. Jour. Bot. 49: 213-220. 1962) have, I believe, admirably demonstrated that *U. inflata* and *U. radiata* Small (= *U. inflata* var. *minor* Chapm.) are specifically distinct. According to Reinert and Godfrey's thorough and beautifully illustrated study, the two taxa are sympatric throughout most of their collective range and often grow intermixed in the same pond. They found the two taxa to be "easily distinguishable" "on the basis of 5 hitherto-neglected, morphological characters . . . and on the basis of 3 reinvestigated quantitative criteria." The two taxa are not known to intergrade and the differences were maintained in culture. Eight distinguishing characters between two taxa is in itself impressive to anyone not a numerical taxonomist but more significant in determining their status in the taxonomic hierarchy is the obvious and highly effective reproductive isolation existing between the two. Infraspecific classification is not intended to be applied automatically to taxa which are difficult for the biologist to distinguish but for populations which lack the hallmark of a species. *Utricularia radiata* clearly seems to be, as Reinert and Godfrey have demonstrated, specifically distinct; there seems to be ample indirect evidence in the lack of intermediates that the two are most effectively reproductively isolated.

3. SPECIES TREATED AS INDIVISIBLE IN WHICH INFRASPECIFIC TAXA OUGHT TO BE RECOGNIZED.

Silene caroliniana Walt. appears in the Carolina Manual without designated infraspecific taxa. In fact *S. caroliniana* var. *pensylvanica* (Michx.) Fernald is placed in synonymy and the inclusion of Alabama in the southeastern distribution of the species suggests that even *S. caroliniana* ssp. *wherryi* (Small) R. T. Clausen is synonymized since it is the only element of the complex known from that state.

Map 1. Distribution of *Silene caroliniana*. *S.c.* var. *caroliniana*, large solid dots; *S.c.* var. *pensylvanica*, small solid dots; *S.c.* ssp. *wherryi*, open circles with small central dot.

The infraspecific variation of *S. caroliniana* was the subject of a very thorough study by Professor Clausen (Rhodora **41**: 575-584. 1939) whose findings have not been fundamentally enlarged upon in the past three decades. In the following year Fernald transferred Clausen's subspecies to varietal status without additional botanical comment. That paper (Rhodora **42**: 239-276, 281-302. 1940) was prefaced, however, by a lengthy discussion of the proper and improper use of subspecies, variety and form. The tenor of Fernald's arguments can be gleaned from the following quotation: "The modern fad of certain botanists, to substitute the heretofore clear term subspecies, erroneously used and often misunderstood by them, for the long established *varietas*, as used correctly for more than two centuries, is . . . a practice which cheapens the status of true subspecies and makes for inaccuracy and misunderstanding."

Hitchcock and Maguire (Univ. Washington Publ. Biol. **13**: 1-73 1947) accepted Clausen's concept of *S. caroliniana* and also treated the three major variants as subspecies. They stated, however, that "in the absence of obvious intermediate material and confluence of characters, it is not improbable that this (ssp. *wherryi*) might ultimately have to be recognized as a distinct species . . ." In passing it might be noted that their almost impossibly small maps with many different symbols are most confusing — so much so that at least two errors are apparent for *S. caroliniana* (Map 1): *Silene caroliniana* ssp. *wherryi* is mapped for the inner coastal plain of North Carolina where it is not known and ssp. *caroliniana* is shown as occurring in the mountains of Tennessee where only ssp. *pensylvanica* has been found.

Kruckeberg (Brittonia **16**: 95-105. 1963) found, excepting *S. caroliniana* and *S. virginica*, that "the species east of the Mississippi River have undergone sufficient genetic divergence to have developed salient morphological gaps reinforced by strong internal barriers to crossing." Artificial crosses result in vigorous but sterile hybrids. Although *S. caroliniana* and *S. virginica* may be artificially crossed (and a few natural crosses are known) Kruckeberg felt it

best to "defer to common regional floristic practice and keep them as separate species."

Kruckeberg stated that "crosses among the three subspecies of *S. caroliniana* are likewise highly fertile" but his table of crosses shows that only two subspecies were available to him: ssp. *wherryi* and ssp. *caroliniana.* The identity of the last seemed unlikely as *S. caroliniana s.s.* is not known from central North Carolina. (In fact no specimen of *S. caroliniana s.l.* is yet known to me from Orange County, the alleged source of the collection). Another collection reported upon by Kruckeberg in an earlier paper (Madroño **15**: 205-215. 1960) as ssp. *caroliniana* from Franklin Co., N. Carolina is ssp. *pensylvanica,* unless it differs from all other collections known from that area. Kruckeberg felt that the subspecies of *S. caroliniana* "are still valid as they coincided with geographic and morphologically distinct variants within the species." Therefore in spite of the hopes expressed by Clausen, biosystematic studies have not as yet provided a new dimension to our understanding of the complex. Such studies have apparently confirmed the fact that the three taxa are more closely related to one another than they are to the other eastern species and that the morphological differences are maintained primarily through geographic isolation.

Unsurprisingly enough my examination of more than eight hundred herbarium specimens* has confirmed the existence of three morphologically distinguishable taxa within the species and reaffirmed the allopatry of each of these taxa. Unlike Clausen, who found that "intermediates do occur, indicating continuity in the series", I found the three taxa to be remarkably clearly delimited. I was not as impressed with the differences in shape of the apex of the basal leaves as have been Clausen and others and found that the specimens could be better correlated geographically if

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*I am indebted to the curators of the herbaria listed below who loaned the specimens which made my study possible. The herbaria are indicated by their Index Herbariorum symbols: DUKE, GA, GH, KY, MO, NCU, NSC, NY, PAC, TENN, US, VBD, VPI and WVA.

the importance of the shape of the apex was not weighed as heavily as the pubescence on the surface of the basal leaves. The difference in pubescence of the calyces seems to me to be more fundamental. I therefore feel that the difference between the *wherryi* is greater than that between the eastern taxa, *caroliniana* and *pensylvanica*.

Consequently neither rigid adherence to the category subspecies advocated by Clausen nor to that of *varietas* practiced by Fernald would allow one to indicate the apparent greater evolutionary divergence between *wherryi* and the two eastern taxa in contrast to the lesser differentiation between *caroliniana* and *pensylvanica*. *Silene caroliniana* appears then to be an excellent example in which two levels of the taxonomic infraspecific hierarchy are required to express our present knowledge of the biological relationship.

Key to the variants of *Silene caroliniana*.

1. Calyces densely glandular-pubescent and narrowly tubular; primarily east of the Appalachian Mts. ..... 1. ssp. *caroliniana*.
   2. Basal leaves rather densely spreading short-pubescent on both surfaces, mostly narrowly to broadly spatulate and obtuse ..... 1a. var. *caroliniana*.
   2. Basal leaves glabrous on both surfaces, mostly narrowly oblanceolate and acute ... 1b. var. *pensylvanica*.
1. Calyces densely pubescent with white eglandular trichomes and broadly tubular; occurring west of the Appalachian Mts. ..... 2. ssp. *wherryi*.

1. *Silene caroliniana* ssp. *caroliniana*

Calyces, pedicels and upper portion of stems densely glandular-pubescent. Calyx narrowly tubular. Surface of basal leaves glabrous or spreading short-pubescent. Range: primarily confined to the Appalachian Mountains or to the area to the east of the Mountains *i. e.* the Atlantic drainage slope.

There are two morphological variants of this subspecies and they can best be recognized by the spreading short-pubescence on the surfaces of the basal leaves of the more

southern element in contrast to the glabrous surfaces of the basal leaves of the northern populations. These seem clearly differentiated and, since I do not feel that variation in the apices of the basal leaves is evidence of hybridization or introgression but part of the expected range of variation, the morphologically delimited populations are clearly allopatric.

1 a. *S. caroliniana* ssp. *caroliniana* var. *caroliniana*.

Basal leaves usually broadly oblanceolate to spatulate and typically with a broadly rounded apex, often (0.5)1.5-3 cm wide, rather densely spreading short-pubescent on both surfaces. Calyces 1.5-1.8(2.0) cm long. Blades of petals reportedly 0.8-1.3 cm long, claws slightly longer than the calyx.

There has been considerable discrepancy in the reports concerning the morphological features of the supposed type in Walter's collection in the British Museum. Fortunately the description is exceptionally full in Walter's Flora for even the obtuse and pubescent basal leaves are mentioned. Hence there can be no doubt as to the taxon to which the name should be applied. Small (Torreya **26**: 67. 1926) stated that the specimen in Walter's herbarium "has the calyx distinctly though sparsely glandular." Clausen (Rhodora 41: 579. 1939) reported that Weatherby's notes on the specimen in Walter's Herbarium indicated "that the basal leaves of this specimen are oblanceolate and acutish and that the pubescence is most nearly matched by a collection from . . . Missouri" (*i. e.* a specimen of ssp. *wherryi*). The reference to "pubescence" is not clear as to whether that of the basal leaves (as Clausen assumed) or that of the calyx is being indicated. In any event Walter's description is unmistakable and would take precedence over any specimen in Walter's collection that is not in accord with the written account just as Shinners (Castanea 27: 71. 1962) has shown for *Bonamia aquatica* (Walt.) Gray.

1 b. *S. caroliniana* ssp. *caroliniana* var. *pensylvanica* (Michx) Fernald, Rhodora 42: 260. 1940.

S. pensylvanica Michx., Fl. Bor. Am. **1:** 272. 1803.
S. caroliniana ssp. *pensylvanica* (Michx.) Clausen, Rhodora **41:** 580. 1939.

Basal leaves usually narrowly oblanceolate and typically with an acute apex, usually 0.5-1.5(2.0) cm wide, glabrous on both surfaces. Calyces (1.0)1.3-1.8 cm long. Blades of petals reportedly 0.8-1.5 cm long, claws usually slightly longer than the calyx.

2. *S. caroliniana* ssp. *wherryi* (Small) Clausen, Rhodora **41:** 582. 1939.
S. wherryi Small, Torreya **26:** 66. 1926.
S. caroliniana var. *wherryi* (Small) Fernald, Rhodora **42:** 260. 1940.

Calyces, pedicels and upper portion of stems densely pubescent with tapering hyaline, eglandular, wide-spreading, pilose trichomes. Calyx more broadly tubular. Surface of basal leaves glabrous. Range west of the Appalachian Mountains in south central Ohio and north central Kentucky, southern Missouri and the northern half of Alabama.

In contrast to the above contention that both subspecies and varieties can be used to advantage in expressing the degree of variation within a species, Raven (Contr. U.S. Nat. Herb. **37:** 167-168. 1969) approvingly paraphrases H. L. Mason's belief that although "two of any three taxa will always be more closely related to one another than they are to the third" and questions whether it is "practical to recognize all such shades of relationship in formal taxonomy." Obviously, although it would be impossible to express hierarchially every shade of variation, I believe we can better express degrees of significant infraspecific variation if we don't assume arbitrarily that only one infraspecific category is to be recognized. Although I have not personally worked with plants in which I have found a need for more than two, I would not arbitrarily suggest that two is the absolute upper limit.

Raven also claims that the Nomenclatural Code "states explicitly that subspecies are the primary unit into which

species are divided, and it is therefore incorrect to use any other infraspecific taxon, such as variety, for the primary division of a species." Such an interpretation is, in my opinion, a complete misrepresentation of the Code. Article 4 lists twenty two categories that usually suffice in classifying plants. It is true that *subspecies* is listed first in the descending series of categories after species just as subfamily is listed first after family and subgenus after genus. Surely one does not conclude from such a hierarchical listing that families can not be divided into tribes unless they are first divisible into subfamilies or that sections are admissible only in genera which have recognizable subgenera. Consequently there is nothing implicit or explicit in the Code to suggest that is is mandatory to use the category subspecies if only one infraspecific taxonomic level is employed.

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Table I
Comparison of Infraspecific Usage in Two Recent North American Floras

	Species	*Ssp. & var.*	*Formae*	*Species/ ssp. & var.*	*Species/ ssp., var., formae*
The Carolinas:	3360	174	0	18.7	18.7
Missouri:	2438	517	297	4.7	2.99

NEW PHANEROGAMS FROM THE ARID NEOTROPICS

R. C. Barneby

In course of field work in Mexico in connection with a projected revision of *Dalea*, and in routine identification at New York Botanical Garden, several undescribed phanerogams have come to light. Descriptions and diagnoses of these are presented:

Psoralea holosericea Barneby, sp. nov., *P. mexicanae* (L. f.) Vail affinis, ob pubem densam sericeo-tomentosam omnium fere partium solum cum ejus var. *Trianae* (Vail) Macbr. comparanda, sed ab hac (in Ecuadoria australi sympatrica) pube longiori (pilis ad 1.2-1.6 nec 0.5-1.1 mm usque longis) et praesertim calycis albo- nec fusco-hirsuti tertia parte longioris dente dorsali subduplo longiori petala subsuperanti absimilis.

Verosimiliter frutex 1-2-metralis habitu *P. mexicanae* simillima, praeter foliorum paginam superiorem tantum secus nervos subappresse pilosulam pilis patulis undique molliter cano-hirsuta; foliorum petiolus 1-1.5 cm longus, foliola ovato-acuminata (3) 3.5-5.5 cm longa; racemi spiciformes paniculatim dispositi ineunti anthesi densiflori 3-3.5 cm longi, ± 1.5 cm diametro, breviter pedunculati et subsessiles; calycis barbato-sericei eglandulosi pube ablata membranacei viridis ± 7 mm longi tubus ad anthesin 2.5-3 mm longus, dens dorsalis aliis paullo longior fere 4 mm longus petala aequans vel breviter superans; petala azureo-marginata, vexillum alaeque 5.7 mm, carina 5 mm longae; calyx fructifer verosimiliter accrescens cum legumine ignotus.

ECUADOR. Azuay: locally common, km 83 out of Cuenca on road to Loja, alt. 3000 m, September 25, 1959, *Bassett Maguire & Celia K. Maguire* 44,307. — Holotypus, NY; isotypi, K, US, USM.

In general habit, in shape and size of leaves, stipules and bracts, and in form of calyx and petals, *P. holosericea* closely resembles *P. mexicana* (L. f.) Vail as interpreted by Macbride (in Field Mus. Bot. 133: 358-360. 1943). Because of the dense, soft, hirsute (and on the stems also subtomentose) pubescence of all parts except the upper leaf surface which is pubescent only in lines along the principal nerves, the new species suggests *P. mexicana* var. *Trianae* (Vail)

Macbride; but the vesture of var. *Trianae*, although similar in quality, is much shorter, and in the inflorescence differs in color. The bracts and calyces of *P. holosericea* are shaggy with long, soft, lustrous, white hairs, whereas those of var. *Trianae* are hirsutulous with shorter and stiffer, mostly ascending and black or fuscous (mixed with a few longer pale) hairs among which arise many stalked or sessile glands. However the presence of glands is a variable feature in the Andean psoraleas and cannot be relied on as a differential character. More important differences are found in the relative proportions of the calyx and petals. In *P. mexicana* (sens. lat.) the petals are ±5 mm long, but at early anthesis project well beyond the small, relatively short-toothed calyx; in *P. holosericea* they are of nearly the same size but are included in the much longer calyx. In consequence the young flowering spike of *P. holosericea* appears substantially thicker than that of any form of *P. mexicana*. The differences may be summarized:

Stem (at least upward), lower leaf-surface and inflorescence densely silky-hirsute with spreading hairs up to 1.2-1.6 mm long; calyx at anthesis ± 7 mm long, pale green beneath the white vesture, eglandular or nearly so, the dorsal tooth ±4 mm long, equaling or slightly surpassing the petals ..... *P. holosericea*

Stem, lower leaf-surface and inflorescence hirsutulous with antrorsely ascending and spreading hairs up to 0.5-0.9(1.1) mm long; calyx at anthesis ±4.5 mm long, livid beneath the largely or partly black vesture, usually glandular, the dorsal tooth 2.2-2.5 mm long, shorter than the petals. ..... *P. mexicana* var. *Trianae*

Polygala (§ *Adenophora*) **evolvulacea** Barneby, sp. nov., *P. macradeniae* Gray affinis sed caulibus gracillimis flexuosis et praesertim floribus subdimidio brevioribus, alis 2-2.7 (nec 4-5.5) mm longis carinae brevioribus nec aequilongis vel longioribus, ulterius ab ejus var. *glanduloso-pilosa* (Chod.) Blake cum qua pube parciuscula brevi congruit foliis anguste obovatis duplo latioribus absimilis.

Caules gracillimi flexuosi debiles prostrati ac incurvi 1-2.5 dm longi ut folia pilis incurvis ± 0.15 mm longis puberuli virides nunc purpureo-tincti; folia 2.5-4.5 mm longa secus ramulos sparsa nec conferta

nec imbricata anguste obovata vel oblanceolata acutiuscula 1-1.9 mm lata glandulis pellucidis utrinque obsessa; racemi brevissime 1-4-flori folio suffulcranti superati; sepala ovata cymbiformia 0.6-0.9 mm longa 0.4-0.5 mm lata extus puberula; alae obovato-cuneatae obtusae 2-2.7 mm longae, 0.9-1.5 mm latae extus pilosulae, totae vel supra medium violascentes; carinae exsertae 2.6-3.6 mm longae luteae lamina oblongo-quadrata obtusa integra 1.3-1.7 mm longa; capsula semenque nisi arillus paullo brevior iis *P. macradeniae* similes.

MEXICO. Tamaulipas: vertical bank of soft crumbling rotted limestone, ±300 m (1000 ft.), brushy hillside on the first bench of Sierra Madre Oriental ±6.5 km (4 mi) W of Antiguo Morelos, November 22, 1966, *Ripley & Barneby* 14,755. — Holotypus, NY; isotypi, CAS, GH, MICH, US.

The center of diversity of *Polygala* subsect. *Adenophora* Blake (Cont. Gray Herb., New Ser. **42**: 54. 1916, subsequently treated as sect. *Adenophora* in N. Am. Fl. **25**: 334-5. 1924) extends through central and southeastern San Luis Potosí into Nuevo León, on the limestones of the Sierra Madre Oriental and the contiguous plateau. All three species known to Blake are either endemic to this region or occur in it. Of the three, *P. glandulosa* H. B. K. and *P. phoenicistes* Blake have broadly obovate leaves and flowers much larger than those of *P. evolvulacea*, which is therefore likely to be confused only with *P. macradenia* Gray and in particular, because of its green, sparsely and shortly puberulent foliage, with the relatively southern and more nearly sympatric *P. macradenia* var. *glanduloso-pilosa* already mentioned in the diagnosis. The new species differs from *P. macradenia* as a whole in its smaller, differently proportioned flower in which the wings are both absolutely and relatively shorter. Furthermore the pliantly flexuous, distally incurved or trailing, very slender and sparsely leafy stems are markedly different from the crowded, stiff and usually erect, densely leafy tufts of *P. macradenia*. From var. *glanduloso-pilosa*, still known only from two Purpus collections from west of the Sierra Madre crest at over 1000 m in San Luis Potosí, it differs in its leaves of lance-obovate rather than almost linear outline, and in its habitat

in a quite alien vegetational belt at only 300 m in the Sierra's eastern foothills.

Polygala (§ *Eurhinotropis*) **erythrorrhiza** Barneby, sp. nov., *P. Tweedyi* Britt. proxime affinis sed caulibus debilibus flexuosis ex ipso radicis carnosae rubro-aurantiacae collo (nec e caudice suffruticuloso) ortis, foliisque latioribus iis racemo oppositis ellipticis membranaceis 2-4 (nec linearibus vel lineari-ellipticis 1-1.5 mm latis absimilis.

Caules graciles omnino herbacei (1) 1.5-3.5 dm longi, ut folia pilis mollibus incurvis minutim densiuscule puberuli virides; folia nisi ima et summa breviora subhomomorpha lanceolato-elliptica vel elliptica acuta mucronata margine revoluta pinnatim paucinervia, saltem media 1-2.2 cm longa 2-5 mm lata; racemi oppositifolii subsessiles geniculati 5-12-flori; flos, capsula semenque fere ut in *P. Tweedyi;* alae pallide roseae glabrae; petala interiora basin versus ciliata, carinae rostro obtusissimo vix 0.5 mm longo.

MEXICO. Guerrero: hanging down out of crevices of soft gypseous-conglomerate rock face, low cliff ± 18 km (11 mi) S of Iguala, 870 m (2600 ft), November 9, 1964, *Ripley & Barneby* 13,737. Holotypus, NY; isotypi, CAS, K, MICH, US.

The small-flowered herbaceous polygalas of subsect. *Eurhinotropis* Blake (Cont. Gray Herb., New Ser. 42: 71. 1916, raised to rank of sectio in N. Am. Fl. **25:** 310 (key) + spp. 99-103 incl. 1924) are a critical group, all of the more widely dispersed members being variable in pubescence of the foliage and flower-parts as well as in size of the individual flower. Specific lines are hard to draw, for the available differential criteria are seldom absolute. The center of speciation lies on the arid altiplano of northern Mexico and adjoining United States; no species has been reported hitherto from south of Hidalgo. The discovery of *P. erythrorrhiza* in the middle Balsas valley south of the Transverse Volcanic Belt thus marks a substantial range extension for the group. The closest relative of *P. erythrorrhiza* is probably the distantly allopatric *P. Tweedyi.* Both have puberulent stems and leaves, and the flower of *P. Tweedyi,* although commonly a little larger, varies in size down to a small extreme hardly different from that of *P. erythrorrhiza.* The best diagnostic features are found in the foliage and habit of

growth. Mature plants of *P. Tweedyi* develop a woody root and suffruticulose caudex, and either all leaves or at least those leaves borne above the middle of the stem and opposed to the racemes are linear to linear-elliptic in outline and of firm, subcoriaceous texture. The stems of *P. erythrorrhiza* spring directly from the truncate apex of a fleshy, coralloid, orange-red taproot, and the homomorphic leaves are all elliptic and of relatively thin texture. In general facies *P. erythrorrhiza* suggests the primarily Texan *P. Lindheimeri* Gray, ordinarily characterized by a vesture of longer spreading hairs, and the too closely related *P. nitida* T. S. Bdg., which seems to be little more than a puberulent phase of it. However this may be, *P. Lindheimeri* and *P. nitida* differ collectively from *P. erythrorrhiza* in the strong tertiary nervature of the leaves, which become prominently reticulate when mature, not merely penninerved. The other described members of subsect. *Eurhinotropis* are more easily distinguished by their small leaves.

Anisacanthus stramineus Barneby, sp. nov., ob bracteas amplas foliaceas calyci amplexo longiores cum *A. abdito* T. S. Bdg. necnon *A. ochoterenae* Miranda comparanda, ab illo foliis floralibus subsessilibus et corolla straminea, ab hoc corolla bracteisque dimidio minoribus facile distincta.

Frutex submetralis, cortice vetustiori albido, caulibus novellis pilis patulis villosissimis eglandulosis, foliis pilis multicellularibus sparsis cum brevioribus capitato-glandulosis crebris commixtis viscido-pubescentibus; folia difformia, caulina (ad anthesin caduca) majuscula petiolata (petiolo ad 1 cm usque longo), lamina ovata vel ovato-lanceolata basi late cuneata ad 2 cm usque longa dorso elevatim costata et pinnatim nervosa, ea ramulorum axillarium flores suffulcrantia oblongo-lanceolata subsessilia vix 1 cm attingentia; bracteae foliaceae lineari-oblongae obtusae calycem amplectentes 6-9 mm longae fere 1 mm latae; calyx 4.5 mm longus, laciniis lineari-attenuatis 3.5 mm longis glanduloso-puberulis; corollae ± 2.5 cm longae glaberrimae stramineae tubus cylindricus 0.95-1.1 cm longus 1-1.2 mm diametro ad fauces paullum ampliatus, labia subaequilonga posterius integrum dorso apicem versus pallide violaceo-pictum anterius fere ad basin 3-partitum lobis 4.5 mm latis; filamenta 10-11 mm longa basi incrassata glaberrima; antherarum thecae subexacte collaterales subaequilongae ± 1.6 mm longae muticae; capsula glabra; semen pallide roseum 1.7 mm longum.

MEXICO. Puebla: arid hills, 1110 m (3700 ft.), near Coxcotlan, November 18, 1966, *H. D. Ripley* 14, 731. Holotypus, NY; isotypus, US.

The only close relative of *A. stramineus* described in the last revision of *Anisacanthus* (Hagen in Ann. Mo. Bot. Gard. **28**: 385-404. 1941) is *A. abditus* T. S. Bdg. of the Pacific slope in Sinaloa. The two species are alike in the large bracts which surpass and conceal the calyx; but *A. abditus* differs greatly in having foliage glabrous below the inflorescence, petioled leaves between the flowers, and a longer, red corolla. An apparently nearer relative has been described since: *A. Ochoterenae* Miranda (in Ann. Inst. Biol. Mex. **12**: 606. 1941), from Morelos. Through the kindness of Dr. A. Gómez-Pompa I have had access to the holotype (*Miranda* 1327, MEXU) and several subsequent collections of *A. Ochoterenae* which resembles *A. stramineus* in having yellow flowers but is easily distinguished by its narrower corolla. This is a little over 5 cm long, and the strap-shaped free segments of the lower lip are nearly 3 cm long but only 3 mm wide. The corolla of *A. stramineus* is only 2.5 cm long, with oblong free segments about 1.5 cm long and 4.5 mm across, that is 3-4 not 10 times longer than wide.

THE NEW YORK BOTANICAL GARDEN
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A NEW SPECIES OF CALAMOVILFA (GRAMINEAE) FROM NORTH AMERICA[1]

KEN E. ROGERS

Calamovilfa arcuata K. E. Rogers, **sp. nov.** — Perennis, usque ad 1.5 m alta vel altior; rhizomata gracilia, brevia; nodi barbati sub annulum cum confertis mollibus adscendo-appressis pilis usque ad 8.0 mm longis; vaginae firmae, confertae, parce pubescentes in dorso cum mollibus longis in tubercula adfixis pilis vel glabrescentes; margines, praecipue apice, dense pilosi; collum circulus densus e longis albis pilis compositus; panicula aperta, purpuracea, 15-45 cm longa, 8-40 cm lata; rami primarii patentes denum adscendentes, superne apice pilosi; pulvini pilosi vel pubescentes; spiculae anguste lanceolatae, purpureo colore tinctae, 6.0-7.4 mm longae; gluma prima ovato-lanceolata, acuta, acuminata vel aristo-aculeata, plerumque arcuata, 2.7-4.1 mm olnga; gluma secunda ovato-lanceolata, acuminata vel etiam aristo-aculeata, arcuata, 4.2-5.4 mm longa; lemma lanceolatum, attenuatum, arcuatum, 5.5-7.0 mm longum, usque ad 2 mm paleam superans; palea lanceolata, attenuata, 5.4-6.2 mm longa, binervis, inter nervos sulcata, pubescens vel pilosa in atque inter nervos, apice breviter bifid scaberuloque.

Perennial, up to 1.5 m or more tall; rhizomes slender, short, brownish, as much as 5.0 mm thick; culms densely tufted, erect, unbranched, round or slightly subcompressed, smooth or slightly scaberulous below the nodes; nodes bearded below the annulus with soft ascending-appressed hairs up to 8.0 mm long; sheaths firm, close, sparsely pubescent on the surface with long, soft tubercle-based hairs or glabrescent, the hairs persistent and dense along the margins and at the apex; sheaths overlapping and persistent at the base, becoming shorter than the internodes above, mostly 6-15 cm long (or the uppermost as much as 22 cm long); collar a dense ring of long, white hairs; ligule erose-ciliate, whitish, convex, 0.2-0.7 mm long, the cilia less than 0.5 mm long; blades flat, linear, attenuate to a slender, thread-like involute point, articulated with the sheaths by a narrow line, 30-85 cm long, 1.5-6.5 mm wide, firm, the nerves approximate, the upper surface bearing soft hairs up to 5.0 mm long, these dense behind the ligule, the surface becoming glabrate toward the apex, the lower surface sparsely pilose toward the base or glabrous; margins of the blades narrowly white cartilaginous, antrorsely scabrid except at the ciliate base.

Panicle terminal, open, purplish, 15-45 cm long, 8-40 cm wide; peduncle 15-38 cm long; primary branches solitary and alternate or

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[1]Contribution from the Botanical Laboratory, The University of Tennessee, N.S. 308.

some of them paired at the nodes, slender, spreading or ascending, pilose or pubescent in the axils, more or less scabrid on the angles, the lowermost as much as 22 cm long; secondary branches ascending, 2-11 cm long; tertiary branches ascending, 2-8 cm long; rachis angled, the angles scaberulous or scabrid; pulvini pilose or pubescent; spikelets paired and solitary, appressed-ascending, narrowly lanceolate, acuminate, tinged with purple, 6.0-7.4 mm long; pedicels scabrid to nearly smooth, the longer of a pair 2.5-8.0 mm long, the shorter 1.0-2.0 mm long; glumes, lemma and palea firm; first glume ovate-lanceolate, acute, acuminate or awn-pointed, usually arcuate, 2.7-4.1 mm long, 1-nerved, the nerve scaberulous on the upper portion; second glume ovate-lanceolate, acuminate or awn-pointed, arcuate, 4.2-5.4 mm long, 1-nerved, the nerve scaberulous on the upper portion; lemma lanceolate, attenuate, arcuate, 5.5-7.0 mm long, 1-nerved, pubescent or pilose on and along the midnerve for ½ to 2/3 its length; callus bearded with white hairs, the hairs 2.0-2.5 mm long, 0.32 to 0.42 the length of the lemma; palea to 2 mm shorter than the lemma, lanceolate, attenuate, 5.4-6.2 mm long, 2-nerved, furrowed between the nerves and pubescent or pilose on and between the nerves, the apex shallowly bifid and scaberulous; stamens 3.0 mm long.

TYPE: TENNESSEE. CUMBERLAND CO.: about 8 miles north-northeast of Crab Orchard, off the old gravel road from Crab Orchard to Rockwood, downstream about 600-800 feet from Antioch Bridge over Daddy's Creek, in a shrub-dominated community, October 3, 1968, *Rogers, Sharp, Delgadillo*, and *Meijer 42409* (US 281796). Isotypes at TENN, US, TAES, ISC, LAF.

Other Specimens Examined:

OKLAHOMA. PUSHMATAHA CO.: Pushmataha Wildlife Refuge, SE Oklahoma, *Porter s.n.*, Sept. 1968 (US).

The genus *Calamovilfa* Hack. has previously been treated as comprising four species in North America. One species, *C. curtissii* (Vasey) Scribn., is endemic to northern Florida. Two other species, *C. longifolia* (Hook.) Scribn. and *C. gigantea* (Nutt.) Scribn. and Merr., occur from southern Canada, Michigan, Indiana and Missouri west to Colorado and Idaho, and south to Texas and Arizona. A fourth species, *C. brevipilis* (Torr.) Scribn., is a coastal plain species reported to occur from New Jersey to South Carolina (Hitchcock, 1951; Gould, 1968).

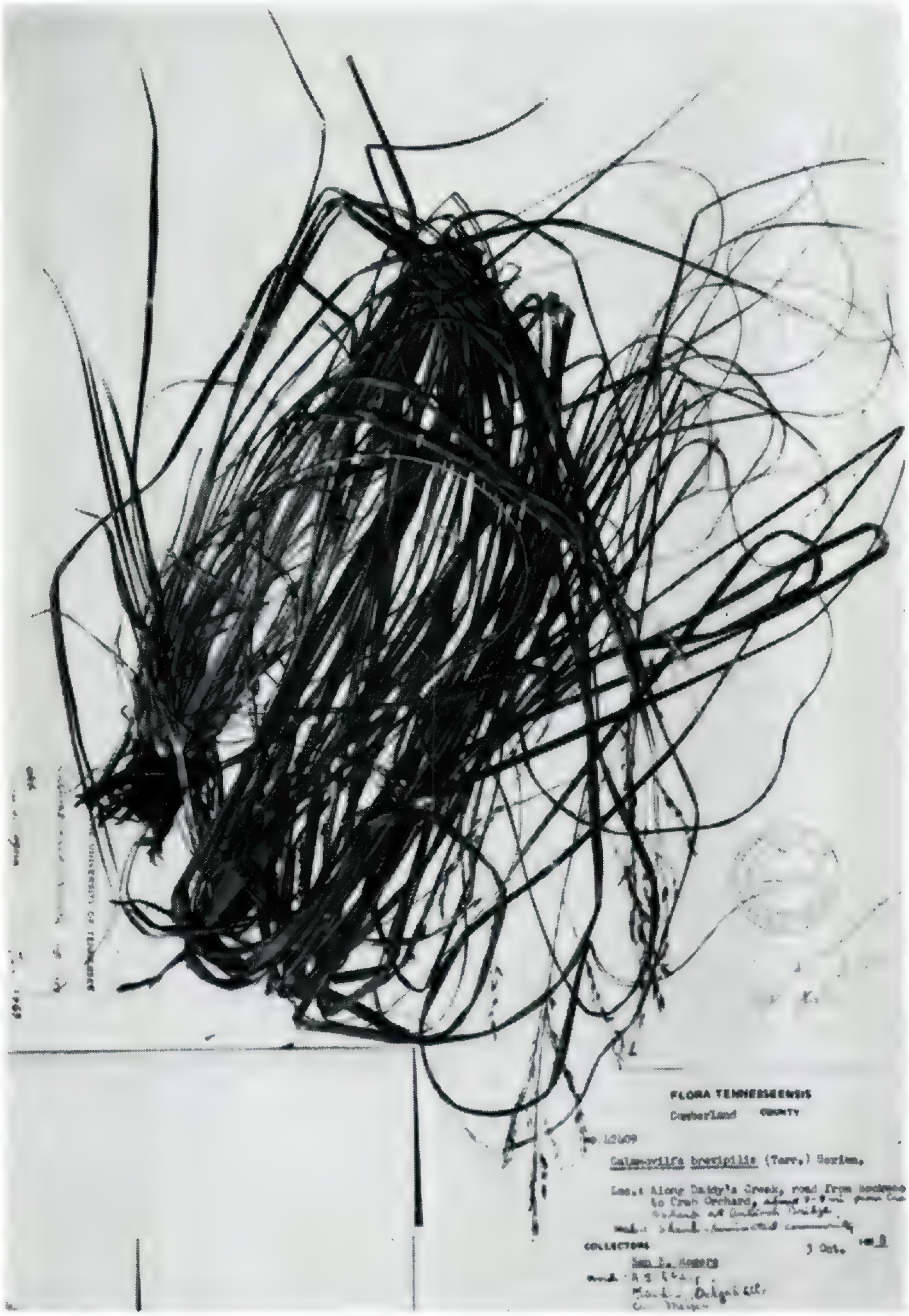


Figure 1. Photograph of *Calamovilfa arcuata (Rogers et al* 42409).

In the fall of 1968, on a plant collecting trip with other botanists to the Cumberland Plateau in Tennessee, I collected a grass which was initially thought to be either a *Panicum* or some unfamiliar grass (Figure 1). Perhaps intuitively, enough material was collected for several herbarium specimens. Later examination of the material led to a tentative identification of it as *Calamovilfa brevipilis*. The discovery of this species on the plateau, although a little surprising, was not inconceivable since a number of Coastal Plain elements occur there. I was also aware that this material was atypical of *C. brevipilis*, if not distinct from it. A number of specimens were sent to agrostologists for observation. Most agreed that it was probably an atypical form of *C. brevipilis*. Dr. Thomas R. Soderstrom, Curator of Grasses at the United States National Museum, after examining my material and a single specimen essentially identical to it from southeast Oklahoma, suggested that I describe the grass as a new species.

A careful comparison was made of *C. arcuata* with herbarium material of other species in *Calamovilfa*. I found that *C. arcuata* was apparently most closely allied to *C. brevipilis* and *C. curtissii*, and between these two it was most closely related to the former.

Thieret (1966) in his Synopsis of the genus *Calamovilfa* (Gramineae) regarded the genus as comprising two sections, Section Calamovilfa and Section Interior. Features of plants in the former section are short rhizomes, ligular hairs less than 0.5 mm long, a line of articulation between sheath and blade, and a distribution in the Coastal Plain of eastern United States. Extensively creeping rhizomes, ligular hairs 0.75 mm or more long, line of articulation not present between sheath and blade, and a distribution in the interior United States and Canada characterize plants of the latter section. After examining the material of *Calamovilfa* from the Cumberland Plateau in Tennessee, I concluded that it belonged to the sect. Calamovilfa.

Utilizing measurements taken both from herbarium specimens and those appearing in the literature, a comparison

was drawn between the species in sect. Calamovilfa (Table 1).

TABLE 1.

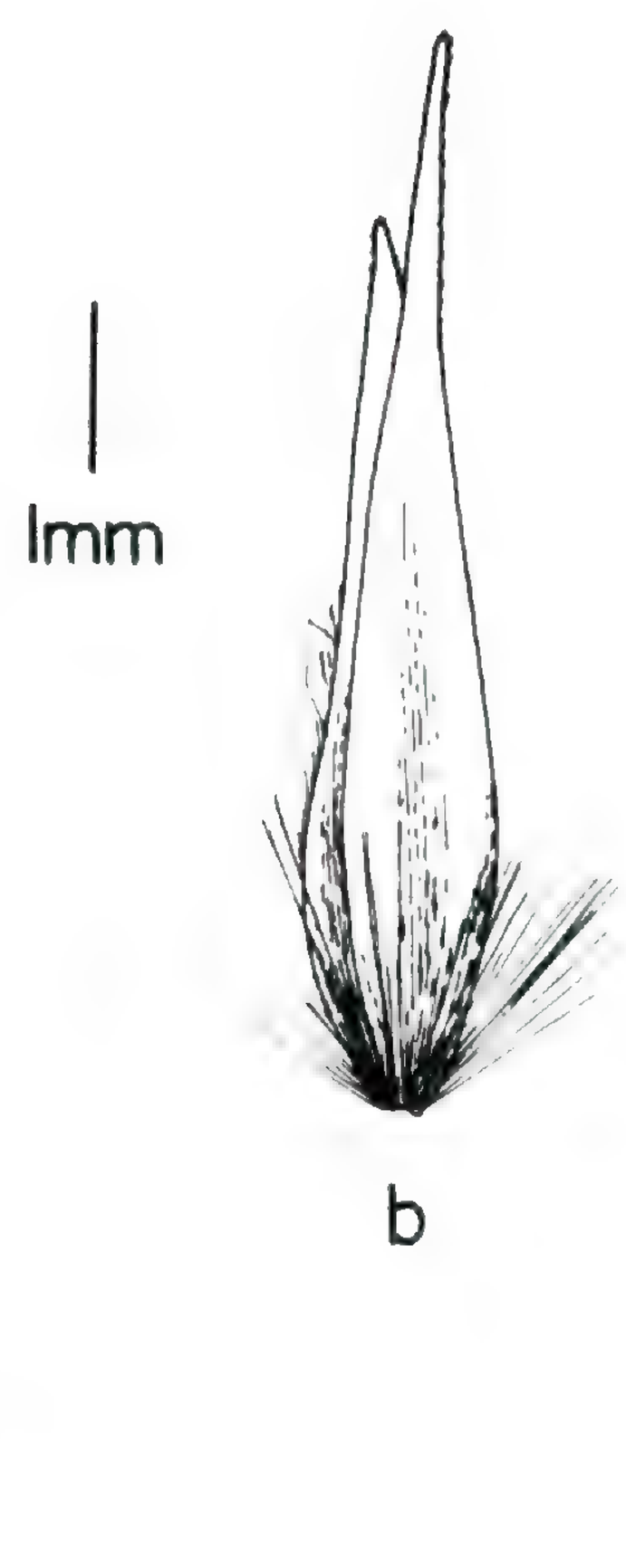
	C. brevipilis	*C. arcuata*	*C. curtissii*
nodes	glabrous	pilose	glabrous
sheaths			
indumentum	glabrous or slightly pubescent at the apex	margins pilose; surface pilose or glabrescent	sparsely pilose or glabrescent
collar	glabrous	pilose	glabrous or sparsely pilose
ligule, length	0.2-0.4 mm	0.3-0.7 mm	0.3-0.4 mm
blades, indumentum	upper surface sparsely pilose at base	upper surface densely pilose at base, the rest of the surface pilose to glabrescent	upper surface pilose at base, the rest of the surface pilose to glabrescent
panicle	open; branches spreading to ascending	open; branches spreading to ascending	contracted; branches appressed
pulvini	glabrous	pubescent or pilose	glabrous
spikelet, length	4.0-5.8 mm	6.0-7.4 mm	3.7-5.6 mm
glumes, shape	acute, not arcuate	acute to acuminate, arcuate	acute, not arcuate
lemma			
length	4.0-5.4 mm	5.3-7.2 mm	3.5-5.2 mm
shape	acuminate, not arcuate	attenuate, arcuate	acute, not arcuate
palea, length	3.8-5.3 mm	5.3-6.2 mm	3.5-5.0 mm
lemma/palea	subequal or nearly so, or palea longer than lemma	lemma longer than palea	subequal
callus hairs, length	1.5 mm	2.0-2.5 mm	1.0-1.5 mm

The above comparison of species illustrates that *C. arcuata* is clearly separated from *C. curtissii* by the open panicle with spreading to ascending branches and the larger spikelets which are 6.0 mm. or more long. *C. curtissii* has a contracted panicle with appressed branches and spikelets not more than 5.6 mm long. *C. arcuata* is distinguished from *C. brevipilis*, and in most cases from *C. curtissii*, by the pilose nodes, the pilose sheaths (at least marginally), the denser indumentum behind the ligule at the base of the blade, the pubescent or pilose pulvini, the arcuate glumes and lemma, the longer lemma and palea, the lemma exceeding the palea rather conspicuously, the longer callus hairs, and the larger spikelets.

The specific epithet *arcuata* refers to the unique outwardly curved glumes and lemma (Figure 2).

In the single caryopsis of *C. arcuata* available for study it was clear that the pericarp and testa were not adherent upon soaking in water. This observation corroborates that of Reeder and Ellington (1960) with regard to caryopses in the genus.

Knowledge of the habitat of *C. arcuata* is limited by the absence of precise information about the ecology of the Oklahoma material. However, I have had an opportunity to observe closely the habitat of the Tennessee population, both at the time it was first collected, and later when I revisited the area in December, 1968. Thus far, only a single population of *C. arcuata* has been found in Tennessee. It appears to be a well established population, numbering some 25 to 30 or more individuals growing separately and gregariously. The plants are growing on rather thin, recent siliceous alluvium overlying sandstone rock. This area projects into Daddy's Creek about 30-60 feet and has a length of 100 feet or so, and is dominated by shrubs under which there are numerous herbaceous plants. There is only a scattering of small trees. The surrounding area has a maturely dissected topography on which there are rich deciduous woods interspersed with pine. A list of the principal plants associated with *C. arcuata*, arranged approximately in their decreasing



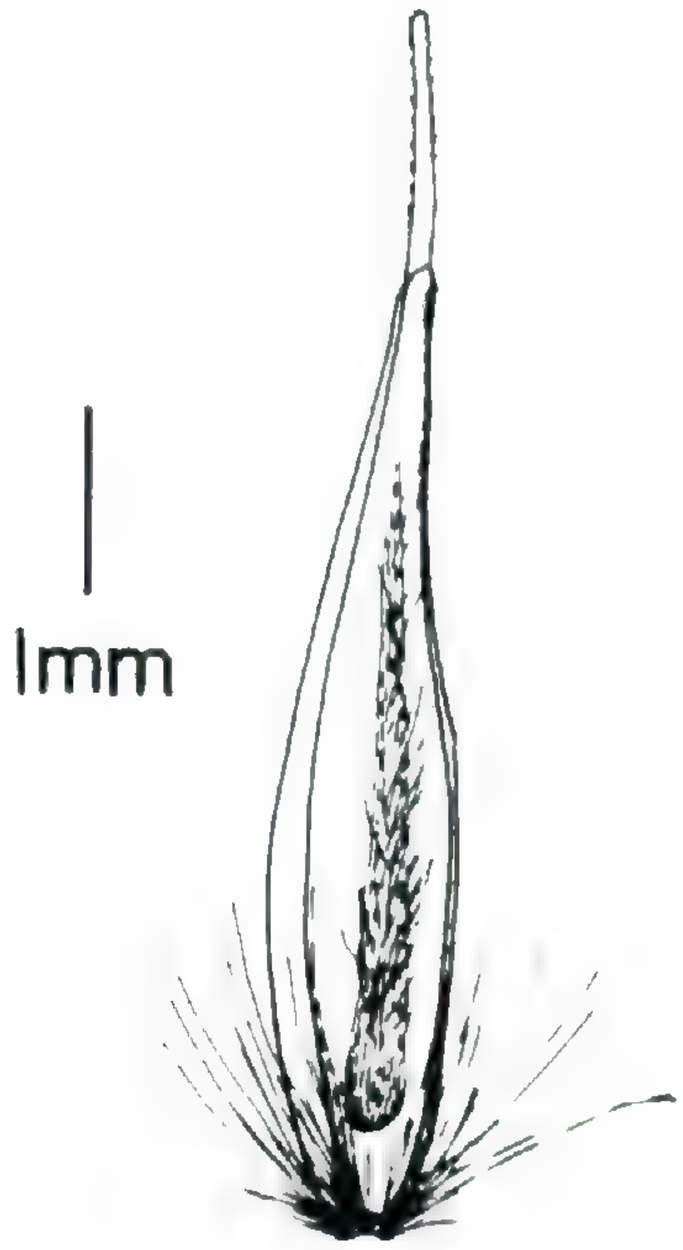


Figure 2. Photograph of drawings of *Calamovilfa arcuata:* a, spikelet, ×25; b, c, floret, ×25.

order of importance in the plant community, is given in Table 2.

TABLE 2.

List of principal flowering plants associated with *C. arcuata*, Daddy's Creek, Cumberland County, Tennessee

Shrubs
Cornus amomum Miller
Alnus serrulata (Aiton) Willd.
Hypericum prolificum L.
Itea virginica L.
Sambucus canadensis L.
Ilex verticillata (L.) Gray
Rosa palustris Marsh
Rhododendron sp. (azalea)

Trees
Liquidambar styraciflua L.
Acer rubrum L.
Pinus virginiana Miller
Nyssa sylvatica Marshall
Diospyros virginiana L.
Fraxinus sp.

Herbs
Andropogon gerardii Vitman
Andropogon scoparius Michx.
Panicum microcarpon Muhl.
Panicum clandestinum L.
Solidago rugosa Miller
Eupatorium fistulosum Barratt
Lobelia cardinalis L.
Carex sp.
Bromus purgans L.
Elymus villosus Muhl.
Lycopus americanus Muhl.
Oxypolis rigidior (L.) Raf.
Scutellaria sp.
Muhlenbergia sylvatica (Torr.) Torr.
Xyris torta Smith
Aster dumosus L.

ACKNOWLEDGMENTS

I wish to express my sincere thanks to Dr. Thomas R. Soderstrom, Curator of Grasses, United States National Museum, Washington, D.C., for examination of type specimens and for helpful observations; Dr. Edward E. Terrell, Botanist, New Crops Research Branch, U. S. Department of Agriculture, Beltsville, Maryland, for the loan of the

Oklahoma specimen; and Mrs. Marie Hicks, Graduate Student, Department of Botany, The University of Tennessee, Knoxville, for preparing the illustrations.

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SAURAUIA SPECIES AND THEIR CHROMOSOMES[1]

DJAJA D. SOEJARTO

Saurauia is a widespread genus of flowering plants, about 250 species of which have been described (Melchior, 1964). The members are represented in both Old and New World tropics and subtropics. The American range extends from Central Mexico in the north to Central Bolivia in the south, through Andean South America. It is not known from the West Indies, and no records indicate its presence in the Guianas and Brazil. According to a recent study by Hunter (1966), 22 species occur in Mexico and Central America, and my present study indicates that 49 species are represented in South America.

The cytology of the genus has never been studied. In his treatment of the Peruvian species of *Saurauia*, Macbride (1955) remarks that ". . . specific characters to this day are not understood and a satisfactory treatment will probably be possible only with cytological as well as morphological data." Hunter (1966), without the benefit of cytological data, was able to show that the species (Mexican and Central American) could be classified comprehensibly on a morphological basis alone. As a non-cytologist, I was stimulated by Macbride's remark, and I set to work to collect cytological "pickles" in the field during the summer of 1963 in the Nariño and Putumayo regions of Colombia. Later, upon examination in the laboratory, the materials which were thought to be in the right developmental stages for the study of meiosis of the pollen mother cells turned out to be very old. Provoked by this failure I collected more cytological materials repeatedly from various parts of South America (Colombia, Ecuador, Peru) during the summers of 1964 and of 1965 and in May and June of 1966 in Colombia. It is from these more adequate materials that the observations here reported were made.

[1]This paper is a minor part of a thesis ("Studies of South American *Saurauia*") submitted to the Department of Biology of Harvard University in partial fulfillment of the requirement for the degree of Doctor of Philosophy.

Plate 1. *Saurauia omichlophila* R. E. Schult. (shrub with white flowers, which the boy is touching). Nariño, above Pasto, Bosque Botana, humid mountain forest, alt. ca. 3000 m.

Plate 2. *Saurauia bullosa* Wawra. Nariño, above Pasto, Bosque Botana, second growth vegetation, alt. ca. 2800 m. Note the wheel-like pattern of insertion of the primary branches.

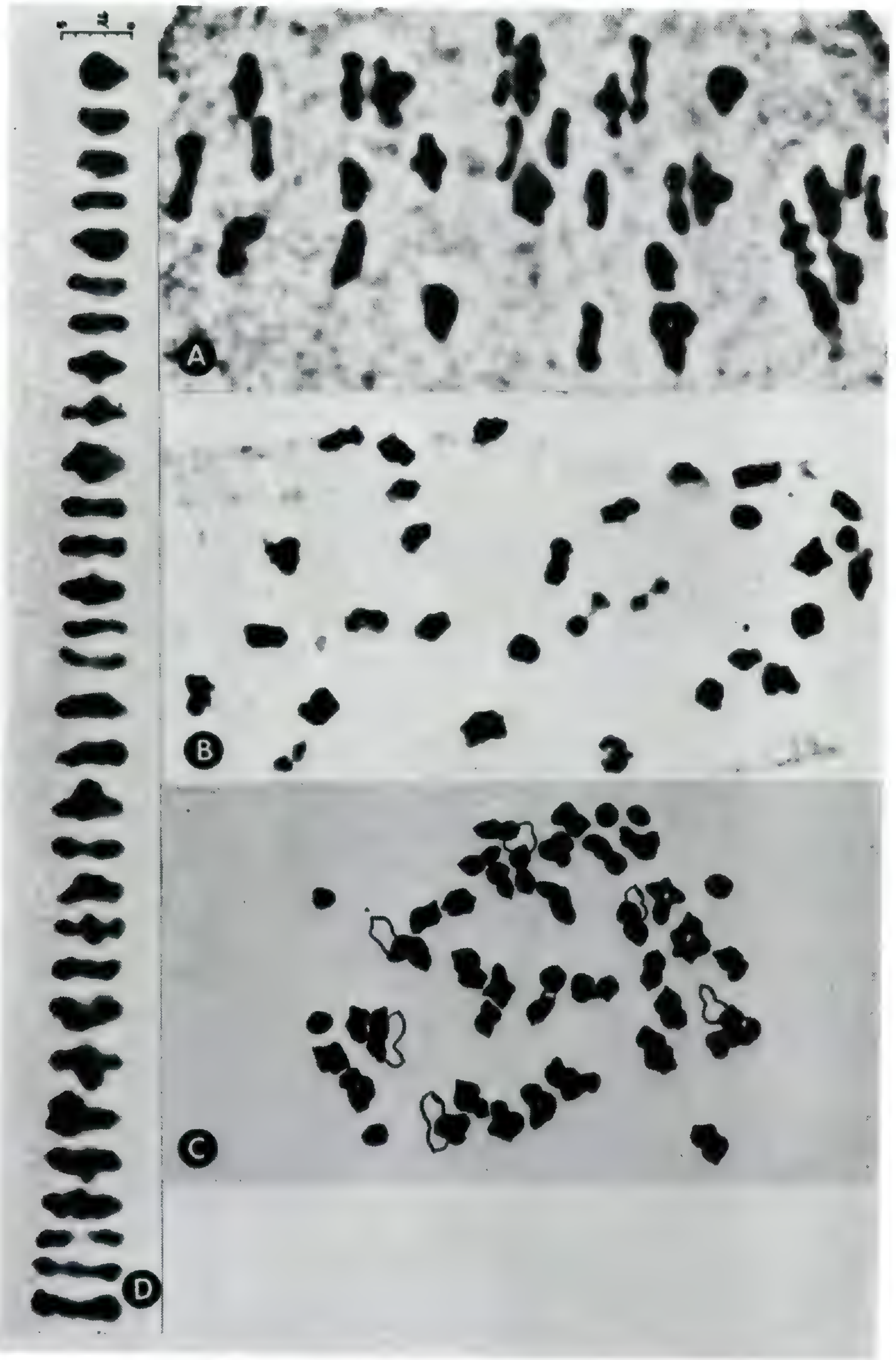

Plate 3. Meiotic configurations in *Saurauia*. A, *S. bullosa*, early anaphase I, equatorial view, $n=30$. B, *S. omichlophila* (voucher: *Soejarto 914*), diakinesis, $n=30$. C, *S. isoxanthotricha* (voucher: *Soe-*

MATERIALS AND METHODS

Flower buds at different stages of development were collected in the field at various times of the day and were killed and fixed immediately in Carnoy's solution (3 parts absolute alcohol, 1 part glacial acetic acid by volume) for from 24 to 72 hours. Since the sepals in most species form a thick cover over the bud, these were first removed or, when the buds are small, were cracked in several places (without removing the sepals), before dipping them into the fixative so that the liquid could penetrate the tissue rapidly. Small vials were used as containers. At the end of the period indicated above, the fixative was substituted by 70% ethyl alcohol. Due to the nature of travel, no serious attempt was made to keep these vials in refrigeration. Only after arrival in the United States, were these vials containing the fixed materials kept in the refrigerator until ready for examination.

For each cytological specimen, a voucher was collected. A complete set of the vouchers is deposited at the Gray Herbarium of Harvard University. Permanent microscope slides are deposited in the Harvard Botanical Museum.

RESULTS

Nineteen individuals representing fifteen species have been observed and the chromosomes counted. The chromosome behavior at meiosis in all but one of the individuals studied appears normal, and the chromosome morphology and number are remarkably stable. Representative meiotic configurations are shown on Plate 3 and Plate 4. The gametic chromosome number of the fifteen species observed is $n = 30$, and the chromosome size during the first metaphase (meta-anaphase) varies but little, as shown by the cut-ups on Plate 3. The chromosome length at this stage ranges from 3.5-6.5μ, the mean length being 5μ.

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jarto 1563), diakinesis, $n=45$ ($42II + 6I$). D, cut-ups of A arranged linearly to show size range and variation of the early anaphase (meta-anaphase) chromosomes. All the same scale, approx. 1600×. A and B photomicrographs, C camera lucida drawing.

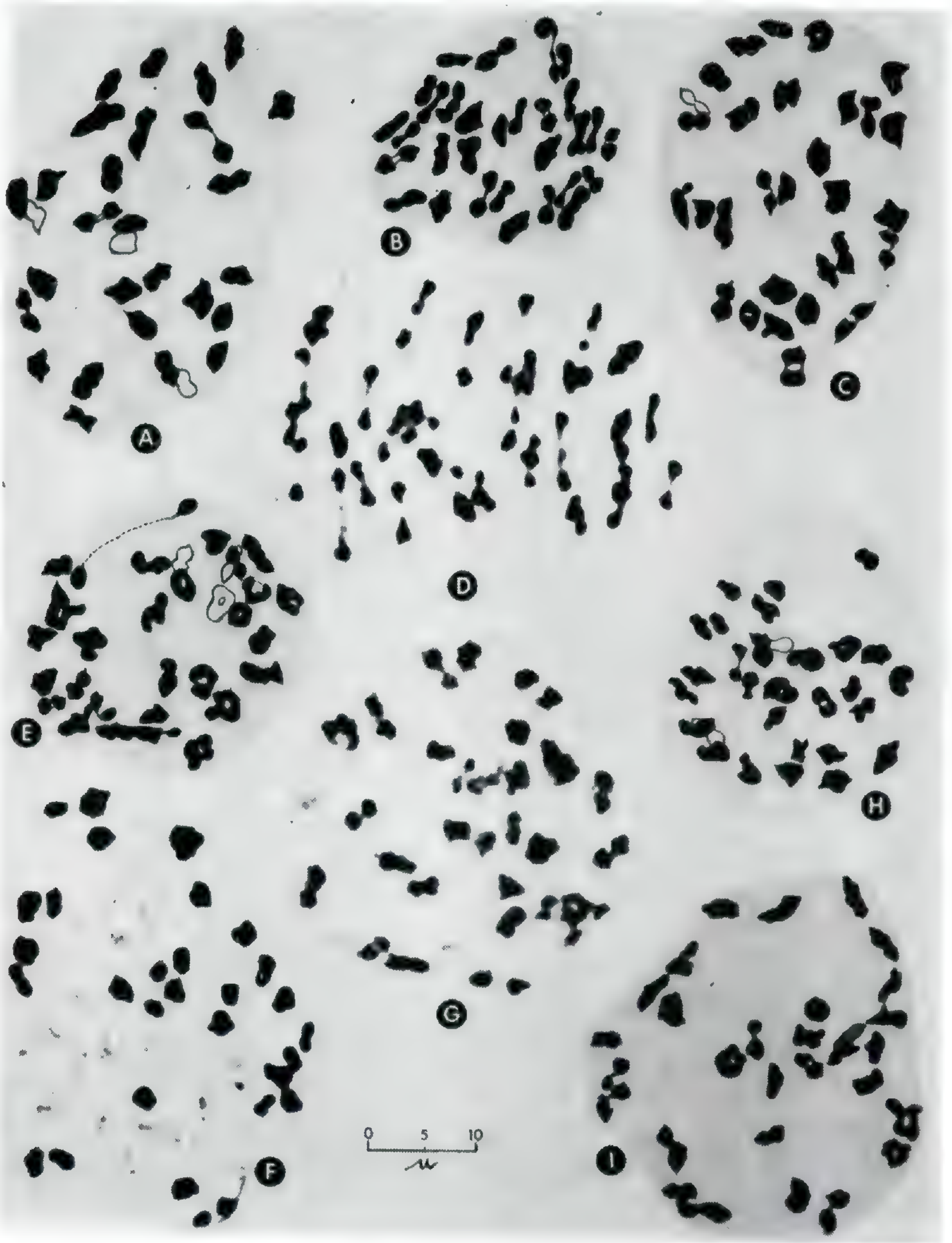

Plate 4. Meiotic configurations in *Saurauia*. A, *S. biserrata* (*Soejarto 1426*). B, *S. Stapfiana* (*Soejarto 2046*). C, *S. pastasana* (*Soejarto 1344*). D, *S. tomentosa* (*Soejarto 1433*). E, *S. brachybotrys* (*Soejarto 2052*). F, *S. Humboldtiana* (*Soejarto 913*). G, *S. aequatoriensis* (*Soejarto 1342*). H, *S. isoxanthotricha* (*Soejarto 1531*). I, *S. portachuelensis (Soejarto 1158)*. All about 1600×. A, B, C, E, H camera lucida drawings; D, F, G photomicrographs; I a tracing of a photomicrograph.

In the course of the study, it was noted that the size of the pollen mother cells is relatively stable in all the nineteen individuals the diameter being 35-50μ. A slight increase in diameter is observed in *Soejarto 1563*, the diameter being 45-60μ. For technical reasons, no detailed study of the meiotic process was attempted, yet some remarks regarding the successive stages observed during the chromosome counts are given below.

The size of the flower buds in which meiosis was observed is not constant in all the species studied; this is due, primarily, to the different sepal thickness and the stamen number in the various species. To cite examples: the flower buds in which meiosis was observed for *S. bullosa* and *S. tomentosa* (with 100-200 stamens and relatively thick sepals) have a diameter of about 10 mm, whereas for *S. chiliantha* and *S. portachuelensis* (with 15-30 stamens and relatively thin sepals) the diameter is about 3 mm. However, anther size, in which meiosis was observed, is essentially the same, being 0.5-1.0 mm in length and about 0.25-0.5 mm in width. Examination of various anthers from the same flower bud from which meiosis was observed shows that the developmental stages within one bud are not uniform. The outer whorls of the anthers (especially those species with high stamen number) were observed to show earlier stages of meiosis than those of the inner whorls. Although I made no quantitative study, I believe that this phenomenon agrees with Brown's study (1935) of the centrifugal maturation of the stamens in *Saurauia subspinosa*.

The pollen mother cells are globose to subglobose and at the resting stage each possesses a rather large nucleus, containing one or two nucleoli (when only one, it is either centric or excentric). During the early phases of meiotic prophase, there is an increase in cell size (from about 30μ to 40-50μ), and the chromosomes appear as densely intertwined threads which are very unsuitable for analysis. Chiasma formation begins to be seen in diplotene rather clearly, but the materials are not favorable for the exact determination of its frequency, both in this stage as well

as in later stages; furthermore, the chromosomes in this stage appear slightly too diffuse for an exact delimitation of the chiasmata. At diakinesis, the chromosomes attain the greatest contraction, and staining reaction with aceto-carmine is good. They appear quite dark and are distributed rather evenly in the cell, which facilitates counting. Both ring and rod bivalents were observed, but they tend to appear as dark blobs, making exact determination difficult. The cytoplasm in most species examined also takes stain, though lightly, which occasionally renders correct counting unfavorable. In some species, such as *S. peduncularis*, the nucleolus is quite late in disappearing, but in the majority, it becomes invisible during diakinesis. At the first meta-phase, the chromosomes become arranged on the equatorial plane which is usually impossible to analyze from a lateral view, and the spindle fibers are only barely discernible. As a result of squashing, the chromosomes in the early first anaphase (meta-anaphase) frequently become well separated (especially in *S. tomentosa* and *S. bullosa*) and good for counting, above all when the pollen mother cells are well separated as a result of thorough maceration. Countings reported here were made either from diakinesis and/or early first anaphase configurations, at an average of 15 cells per preparation. During the early first anaphase, the bivalents are held together by one or two terminal chiasmata or one interstitial chiasma. In this stage, the position of the centromeres could also be observed, either median to submedian or subterminal, the majority being subterminal. No lagging chromosomes were observed during the first anaphase in the individuals with $n = 30$, though, very rarely, bridge formations were noted. In *Soejarto 1563*, however, the univalents usually move to the poles earlier than the bivalents, though occasionally they lag behind; bridge formation was also observed. It should be noted that at the metaphase plate, in the case of *Soejarto 1563*, the univalents are distributed randomly. At the dyad stage, presumably at the beginning of homotypic division, the chromosomes are sometimes distributed rather evenly to facilitate counting.

At the second metaphase and anaphase, the two sets of the spindle fibers lie either in the same plane or at right angles to each other. Finally, cytokinesis is of simultaneous type and the tetrad arrangement of the pollen grains is tetrahedral.

The developmental stage within a single anther is not uniform (synchronous) in all the species examined; although usually one or two meiotic stages are represented, very frequently more were observed, e.g., diakinesis is observed among the numerous pollen mother cells, either in the first metaphase and/or anaphase, even in telophase to tetrad stage. The only explanation which I can offer is that this phenomenon may have been the result of the different collecting time of the specimens. In all the individuals studied, I always observed pieces or complete packets of rhaphides among the pollen mother cells. Presumably, these are present within the anther tissue and became broken and separated during maceration and squashing.

The results of chromosome counts are summarized in the following Table, where the order of the species is listed geographically, in a north-to-south and west-to-east order, corresponding alphabetically to the order of the species in the accompanying map.

DISCUSSIONS AND CONCLUSIONS

This study has made clear that chromosome number and morphology in *Saurauia* appear to be of little use in specific classification and grouping. At least 14 species have highly similar chromosome morphology, with gametic chromosome complement of $n = 30$. However, any statement at the present stage of our knowledge should be considered tentative, and a final conclusion must await further study, preferably including comparative data of representatives from Central America, Mexico, and Asia.

The existence of an individual with a gametic chromosome number of $n = 45$ (39-42 bivalents plus 12-16 univalents) can be explained as a result of interspecific hybridization. Mitotic figures obtained from root tip smear

	SPECIES	VOUCHER SPECIMEN	ORIGIN	ALTITUDE (m.)	MEIOTIC PAIRING
A.	*S. brachybotrys* Turcz.	Soejarto 2052	Colombia, Dpto. Antioquia, Medellin, Sta. Helena	2000	30*II*
B.	*S. ursina* Tr. & Pl.	Soejarto 2040	Colombia, Dpto. Antioquia, Las Palmas	2000	30*II*
C.	*S. Stapfiana* Busc.	Soejarto 2045 2046	Colombia, Dpto. Antioquia, Sonsón	2800	30*II*
D.	*S. chiliantha* R.E. Schult.	Soejarto 2047	Colombia, Dpto. Antioquia, Sonsón	2800	30*II*
E.	*S. Humboldtiana* Busc.	Soejarto 913	Colombia, Dpto. Cundinamarca Salto de Tequendama	2700	30*II*
F.	*S. peduncularis* Tr. & Pl.	Soejarto 938, 1456	Colombia, Dpto. Nariño, Río Guasa	1500	30*II*
G.	*S. omichlophila* R.E. Schult.	Soejarto 914, 1493	Colombia, Dpto. Nariño, Bosque Botana	3000	30*II*
H.	*S. isoxanthotricha* Busc.	Soejarto 1531	Colombia, Com. Putumayo, Cro. Portachuelo	2300	30*II*
	S. isoxanthotricha Busc.	Soejarto 1563	Colombia, Com. Putumayo, Cro. Portachuelo	2300	(39*II*-42*II*) + (12*I* -6*I*)
I.	*S. bullosa* Wawra	Soejarto 1473	Colombia, Dpto. Nariño, Bosque Botana	2900	30*II*
J.	*S. tomentosa* (HBK.) Spreng.	Soejarto 1433	Colombia, Dpto. Nariño, El Encano	2800	30*II*
K.	*S. portachuelensis* R.E. Schult.	Soejarto 1158	Colombia, Com. Putumayo, Cro. Portachuelo	2700	30*II*
L.	*S. putumayonis* R.E. Schult.	Soejarto 1573	Colombia, Com. Putumayo, Cro. Portachuelo	2300	30*II*
M.	*S. aequatoriensis* Sprague	Soejarto 1342	Ecuador, Prov. Tungurahua, Baños	1800	30*II*
N.	*S. Prainiana* Busc.	Soejarto 1344	Ecuador, Prov. Napo-Pastaza, Shell Mira	1300	30*II*
O.	*S. biserrata* (R. & P.) Spreng.	Soejarto 1426	Perú, Dpto. Huanuco, above Chinchao	2500	30*II*

TABLE I. Results of chromosome counts.

Agricola of Universidad de Nariño, and Dr. Alvaro Fernández P., director of the Botany Department, Instituto Ciencias Naturales, Universidad Nacional, Bogotá.

Finally, I wish to thank my wife, Mariela, for her constant encouragement, and for typing the manuscript. Any errors and/or misinterpretations found in this paper, however, are my sole responsibility.

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ADDITIONAL CHROMOSOME NUMBERS IN BRAZILIAN COMPOSITAE

JAMES R. COLEMAN

While serving as a research taxonomist at the Instituto de Botânica of São Paulo, Brazil, I had the opportunity to collect material of Brazilian Compositae for cytological study. A previous report on this study has been published (Coleman 1968).

In the present paper 40 counts are reported for 35 species of 18 genera (Table 1). Initial reports are given for 29 species and 2 genera. The initial generic reports are for *Elvira*, $n = 12$, and *Ichthyothere*, $n =$ ca 33.

The methods used are identical to those described by Coleman (1968). The material of *Eupatorium ballotaefolium*, *E. organense* and *E. tremulum* was determined by Dr. Lyman B. Smith and *Simsia dombeyana* by Dr. J. Cuatrecasas. My appreciation is sincerely expressed. All other identifications are my own. A complete set of voucher specimens is deposited in the University of Georgia Herbarium and a nearly complete set in the Herbarium of the Instituto de Botânica of São Paulo, Brazil.

VERNONIEAE

The report of $n = 16$ for *Centratherum punctatum* agrees with an earlier report for that species based on Panamanian material (Turner and King 1964). No other counts have been reported for the genus.

EUPATORIEAE

The count of $n = 10$ for *Ageratum campuloclinoides* is the initial report for the species. Robinson (1913) considered *A. campuloclinoides* a doubtful *Ageratum* and suggested its affinities to be with *Trichogonia*. Since the counts reported to date for *Trichogonia* agree with those of *Ageratum* in being based on $x = 10$, chromosome number is no aid in better defining the relationship of *Ageratum campuloclinoides*.

The report of $n = 10$ for *Alomia fastigiata* agrees with a previous report for this species (Coleman 1968). The Central American *Alomia microcarpa* (Benth.) Rob. has also been reported as $n = 10$ (Turner and King 1964). Counts of $n = 9$ are reported for two populations of *Alomia longifolia* (Gardn.) Rob. This species was originally described in the genus *Ageratum*, but was subsequently transferred to *Carelia* and later *Alomia*. No reports are available for *Carelia*, but previous reports for both *Ageratum* and *Alomia* are based on $x = 10$.

North American species of *Stevia* have been reported as $n = 11$, 12 and 17 (Powell and Turner 1963). With the report of $n = 12$ for *Stevia organensis*, counts of $n = 11$ and 12 have now been reported for Brazilian species.

The count of $n = 10$ for *Eupatorium laetevirens* agrees with an earlier report for the species. The report of $n = 10$ for *E. ballotaefolium* concurs with a count presented for Colombian material of that species (Powell and King, 1969). I have previously reported $n = 30$ for *E. ballotaefolium* from southern Brazil (Coleman, 1968).

ASTEREAE

Counts of $n = 9$ for species of *Baccharidastrum* and *Baccharis* are in agreement with previous reports for these genera.

HELIANTHEAE

Blainvillea rhomboidea, $n = 17$, is the second species of the genus to be reported. *Blainvillea latifolia* DC. has been reported as $n = 39$ (Mehra et al 1965). An approximate count of $n = 24 \pm 2$ is reported for *Spilanthes acmella*. Previous counts of $n = 7$ (Malik and Ahmad in Cave 1964) and $n = 12$ (Mehra et al 1965) have been reported. Turner et al (1962) have shown a diploid, tetraploid and hexaploid series to exist in *S. americana* Hieron. A similar situation evidently occurs in *S. acmella*.

The counts of $n = 12$ for *Elvira biflora* and $n =$ ca 33 for *Ichthyothere rufa* are the initial reports for these genera.

ANTHEMIDEAE

The report of $n = 9$ for *Anthemis nobilis* is consistent with previous reports for the genus.

SENECIONEAE

Counts reported for species of *Senecio* are consistent with the majority of previous reports for that genus in being based on $x = 10$.

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Table 1

Species	*n*	Locality
VERNONIEAE		
Centratherum punctatum Cass.	16	State of Bahia; Correntina. 523
EUPATORIEAE		
*Ageratum campuloclinoides Baker	10	State of Goiás: Alvorada, between Posse and Formosa. 572
Alomia fastigiata (Gardn.) Benth.	10	State of Minas Gerais: Serra do Cipó, ca 75 km NNE of Belo Horizonte. 598
*Alomia longifolia (Gardn.) Rob.	9	State of Minas Gerais: Serra do Cipó, ca 75 km NNE of Belo Horizonte. 596
*Alomia longifolia (Gardn.) Rob.	9	State of Bahia: ca 5 km E of Morro do Chapéu. 499
*Eupatorium amydalinum Lam.	17	State of Minas Gerais: 15 km W of Campanha. 466
Eupatorium ballotaefolium H.B.K.	10	State of Bahia: Gameleira, Município of Irecê. 477
*Eupatorium bupleurifolium DC.	10	State of São Paulo: 8-10 km ESE of Campos do Jordão. 602
Eupatorium laetevirens H. & A.	10	State of São Paulo: ca 5 km N of Campos do Jordão. 599
*Eupatorium organense Gardn.	10	State of Rio de Janeiro: Parque Nacional de Itatiaia. 578
*Eupatorium tremulum H. & A.	10	State of Bahia: Veredãozinho, Município of Correntina. 554
*Stevia organensis Gardn.	12	State of Rio de Janeiro: Parque Nacional Serra dos Orgãos. 575
ASTEREAE		
*Baccharidastrum rivulare (Gardn.) Herter	9	State of Rio de Janeiro: Maromba, Parque Nacional de Itatiaia. 471
*Baccharidastrum triplinervium (Less.) Cabrera	9	State of São Paulo: São Bento de Sapucaí. 445

Species	*n*	Locality
*Baccharis brevifolia DC.	9	State of São Paulo: 8-10 km ESE of Campos do Jordão. 438
*Baccharis burchellii Baker	9	State of São Paulo: 8-10 km ESE of Campos do Jordão. 434
*Baccharis cf. dracunculifolia DC.	9	State of São Paulo: Parque do Estado, São Paulo. 607
*Baccharis elaeaginoides Steud.	9	State of Minas Gerais: Brejo de Lapa, Parque Nacional de Itatiaia. 437
*Baccharis ligustrina DC.	9	State of São Paulo: 8-10 km ESE of Campos do Jordão. 443
*Baccharis mesoneura DC.	9	State of São Paulo: 8-10 km ESE of Campos do Jordão. 444
*Baccharis tarchonanthoides DC.	9	State of Minas Gerais: ca 25 km E of Camanducaia. 431
Baccharis sp.	9	State of Minas Gerais: ca 30 km E of Camanducaia. 435
HELIANTHEAE		
*Bidens gardneri Baker	24	State of Minas Gerais: Serra do Cipó, ca 75 km NNE of Belo Horizonte. 591
*Blainvillea rhomboidea Cass.	17	State of Minas Gerais: Lagoa Santa. 584
*Blainvillea rhomboidea Cass.	17	State of Bahia: Correntina. 527
*Calea serrata Less.	19	State of Minas Gerais: ca 35 km SSE of Caxambu. 467
**Elvira biflora DC.	12	State of Bahia: Correntina. 519
**Ichthyothere rufa Gardn.	ca33	State of Goiãs: Alvorada, between Posse and Formosa. 569
*Melampodium paniculatum Gardn.	25-27	State of Goiãs: Alvorada, between Posse and Formosa. 570
*Melampodium paniculatum Gardn.	26	State of Minas Gerais: Lagoa Santa. 588
*Simsia dombeyana DC.	17	State of Bahia: 12 km W Irecê. 505
Spilanthes acmella L.	24+2	State of Bahia: Correntina. 532
*Wulffia stenoglossa DC.	30	State of Bahia: Correntina. 529
ANTHEMIDEAE		
*Anthemis nobilis L.	9	State of Rio de Janeiro: Parque Nacional Serra dos Orgãos. 574

SENECIONEAE

*Senecio cuneifolius Gardn.	50	State of Rio de Janeiro: Parque Nacional Serra dos Orgãos. 577
*Senecio desiderabilis Vell.	45-50	State of São Paulo: 8-10 km ESE of Campos do Jordão. 457
*Senecio hemmendorffii Malme	45-50	State of Minas Gerais: ca 25 km E of Camanducaia. 461
*Senecio hemmendorffii Malme	50	State of Minas Gerais: ca 25 km E of Camanducaia. 458
*Senecio icoglossus DC.	20	State of Minas Gerais: Brejo de Lapa, Parque Nacional de Itatiaia. 453
*Senecio icoglossus DC.	20	State of São Paulo: 8-10 km ESE of Campos do Jordão. 454

*Species not reported previously
**Genera not reported previously

STUDIES IN THE COMPOSITAE-EUPATORIEAE, XV. JALISCOA, MACVAUGHIELLA, OAXACANIA, AND PLANALTOA.

R. M. KING AND H. ROBINSON

Continuing studies of the genera of the Eupatorieae have shown the need for the following revisions and clarifications. In the case of *Oaxacania*, it seems fitting to make comparison with the closely related *Carterothamnus*. *Macvaughiella* and *Jaliscoa*, each with two described species, have proved to have too narrow a species concept. *Planaltoa* has shown a number of previously undescribed useful characteristics when observed microscopically.

Jaliscoa S. Watson Proc. Amer. Acad. Arts Sci. 25: 153. 1890. (Type species, *Jaliscoa pringlei* S. Wats.)

Suffrutescent woody shrubs to 3 meters tall, ternately branched above. Stems erect, appressed-puberulous, very faintly striate. Leaves opposite or ternate, thin, very obscurely puberulous; blades ovate to broadly ovate, the margins crenulate-serrulate to sharply serrate, up to 16 cm long and 11 cm wide. Inflorescence a cymose-panicle; heads discoid, campanulate, up to 5 mm broad and ca 9 mm high (including style branches), ca 15 flowered, receptacle paleaceous, slightly convex or flat, phyllaries ca 12, imbricated, lanceolate, ca 3.5-4.0 mm long, apex obtuse or acute; corollas white, campanulate, ca 5 mm long (including lobes), 5-lobed, glabrous; stamens 5; anthers appendaged, the latter ca 225 μ long; style branches 2, greatly exserted at maturity, papillose, style slightly glandular; pappus an obscure, entire, callus border or a lacerate-fimbriate crown; achenes ca 2.5 mm long, dark brown, 4 angled, sparsely setose, setae biseriate; base of achene forming a distinct carpopodium; pollen spherical, tricolpate, distinctly spinose, ca 20-23 μ in diameter, chromosome number not determined.

Jaliscoa pringlei S. Watson, Proc. Amer. Acad. **25:** 153. 1890.
[MEXICO: JALISCO: talus of cool ledges, bluffs of the Rio Grande de Santiago, Oct. 12, 1889, *C. G. Pringle* 2491. (Holotype GH!, Isotypes G!; MEXU!; MO!; NY!; PH!; UC!; US!)]

Jaliscoa pappifera S. F. Blake, Contr. U.S. Nat. Herb. **22:** 587. 1924.
[MEXICO: MORELOS: barranca near Cuernavaca, 4500 ft, *C. G. Pringle* 9931. (Holotype US!, Isotypes F!; GH!; MO!; NY!)]

Additional specimens examined:
MEXICO: JALISCO: Puente San Pedro, 5 mi. SW of Tecalitlán, 1200 m., *McVaugh & Koelz* 1299 (MICH); 11-12 mi. SW of Autlán, ca. 1000 m., *McVaugh & Koelz* 873 (MICH); 2.5-4.0 mi. above (north of) La Cuesta, road to Talpa de Allende, 800-1000 m., *McVaugh* 21201 (MICH); barranca of Guadalajara, 4500 ft., *Pringle* 11544 (F, MICH, MO, US). Michoácan: Púerto Cruces, Coalcoman, *Hinton* 12374 (MICH). Morelos: barranca near Cuernavaca, 5000 ft., *Pringle* 6158 (F, ENCB, MEXU, MO, NY, PH, UC, US). State either Guerrero or Michoacán, Sierra Madre, *Langlassé* 575 (G, MICH, US).

After investigating a number of specimens, we find that only one species can be recognized in this complex.

The stems of this species seem to be particularly susceptible to insect damage, and the resulting numerous perforations are almost a characteristic.

Macvaughiella R. M. King and H. Robinson Sida 3 (4): 282. 1968.

Schaetzellia Sch.-Bip. Flora 33: 419. 1850. Not *Schaetzellia* Klotzsch, Allgemeine Gartenzeitung 1849: 82. 1849.

(Type species *Schaetzellia mexicana* Sch-Bip.)

Perennial or suffrutescent herb to one meter tall, sparingly branched. Stems mostly single, erect, pubescent, striate. Leaves thin, pubescent, deltoid to rhomboid, the margins serrate to dentate; blades up to 3 cm broad, up to 3.8 cm long. Inflorescence corymbose; heads discoid, campanulate to turbinate, 2-4 mm broad, ca 7 mm tall (including style branches), 16-25 flowered, receptacle conical, naked, phyllaries ca 10, imbricated, ovate-lanceolate, ca 5 mm long, ca 1.25 mm wide, apex acuminate; corollas white, funnelform, ca 3 mm long (including lobes), 5 lobed (lobes slightly longer than wide) outer surface of lobes bearing both glands and nonglandular uniseriate hairs; stamens 5; anthers appendaged, the latter ca 100 μ long and ca 150 μ wide around base; style branches 2, exserted at maturity, style bearing occasional glands ventrally; pappus consisting usually of 2 more rarely 1 or 3-4 setae, usually equaling the length of the corolla; achenes when dry very flat, dark brown, ca 2 mm long, base of achene forming a distinct carpopodium; pollen spherical, tricolpate, distinctly spinose, ca 18 μ in diameter; chromosome number not determined.

Key to varieties of *Macvaughiella mexicana*.

Phyllaries essentially glabrous ..... *M. mexicana* var. *mexicana*
Phyllaries pubescent ..... *M. mexicana* var. *standleyi*

Macvaughiella mexicana (Sch.-Bip.) R. M. King and H. Robinson var. *mexicana*

Schaetzellia mexicana Sch.Bip., Flora **33**: 419. 1850.
[MEXICO: VERACRUZ: Bord de la rivière à Acasonica, 1200 ft, Jan 1839, *J. Linden* 1168. (Holotype B, destroyed, Isotype P! Photo US!)]
Macvaughiella mexicana (Sch.-Bip.) R. M. King and H. Robinson, Sida **3**(4): 282. 1968.

Additional specimens examined:
MEXICO: VERACRUZ: Mirador, *Liebman 63* (C); Puente Nacional, *Purpus* 14284 (A, UC); Zacuapan, Fortin, *Purpus* 2855 (US); near Rancho Viejo, *Purpus* 16220 (A); Barranca de Tenampa, *Purpus* 2189 (F, GH, MO, P, UC, US); without precise locality, *Galeotti* 2302 (P, W).

Macvaughiella mexicana (Sch.-Bip.) R. M. King and H. Robinson var. *standleyi* (Steyermark) R. M. King & H. Robinson *stat. nov.*
Schaetzellia standleyi Steyermark, Publ. Field Mus. Nat. Hist., Bot. **23**: 107. 1944.
[GUATEMALA: CHIQUMULA: Montaña Castilla, vicinity of Montaña Cebollas, along Río Lucía Saso, 3 mi SE of Quezaltepeque, alt. 1200-1500 m, Nov 6, 1939, *J. A. Steyermark* 31344 (Holotype F! Photo US!)]
Macvaughiella standleyi (Steyermark) R. M. King and H. Robinson, Sida **3**(4): 282. 1968.

Additional specimens examined:
MEXICO: VERACRUZ: Zacuapan, Sulphur Spring, *Purpus* 2189a (F, NY).
GUATEMALA: JALAPA: vicinity of Jalapa, *Standley* 76699 (F, US), 77406 (F); Jutiapa: quebrada above Ovejero, on road between Monjas (Dept. Jalapa) and El Progreso, alt. ca 1400 m, *Standley* 77645 (F); Lago Retana, between Ovejero and Progreso, *Steyermark* 32041 (F).
EL SALVADOR: LA LIBERTAD: road to La Libertad, *Molina, Burger & Wallenla* 16687 (F); between Guayabal and Río Guaza, *Calerón* 1936 (US); SAN VICENTE: vicinity of San Vincente, *Standley & Padilla* 3639 (F, GH).
HONDURAS: CHOLUTECA: vicinity of San Marcos de Colón, *Standley* 15903 (F, GH, US). EL PARÁISO: along or near Río California, between Río Choluteca and Jacaleapa, *Standley* 17176 (F); Río Choluteca at Ojo de Agua, *L. O. Willliams* 17310 (F, GH, US), *Standley* 4683 (F, GH). MORAZÁN: El Quebracho, above El Zamorano, *Standley* 357 (F); quebrada El Horno, entre El Frijolar y Tabla Grande, *Molina* 833 (F); Matorrales secos de Puente Colorado, al norte de Tegucigalpa, *Molina* 3885 (F); near Río El Quebracho above El Jicarito, *Standley* 27753 (F, GH, MO, US); drainage of the Río Yeguare about Longitude 87° W. and Latitude 14° N., *L. O. Williams* 17039 (F, GH,

MO, US), *Molina* 1758 (F, GH, MO, US), *L. O. Williams & Molina s.n.* (F, US); slopes of Cerro de Uyuca, along trail between Hoya Grande and Valle Encantado, *Standley* 15246 (F, GH, NY, US); region of El Jicarito, above El Zamorano, *Standley* 25134 (GH).

It should be noted that the ranges of the two varieties do overlap in Veracruz as indicated by collections cited as *Purpus* 2189.

Oaxacania B. L. Robinson & J. Greenm. Amer. Journ. Sci. III. **50:** 151, 152. 1895. (Type species, *Oaxacania malvaefolia* B. L. Robinson & J. Greenm.)

Sprawling herbs or sub-shrubs up to one meter long, somewhat woody at base, many branched. Stems striate, covered with glandular hairs. Leaves alternate, blades thin, orbicular or reniform, 3-7 cleft two thirds or more toward base, lobes oblong, glandular pubescent on both surfaces, up to 3.5 cm wide and long, petioles 2-3 cm long. Inflorescences numerous, short peduncled, monocephalic; heads discoid, campanulate, 1-1.2 cm high (including style branches), ca 100 flowered, receptacle paleaceous, convex, phyllaries ca 30-40, in 5 series, lanceolate, 3 nerved, corollas white, campanulate, ca 6.5 mm long (including lobes), 5 lobed, outer surface covered with numerous long stalked glands; stamens 5, anthers appendaged, the latter ca 60 μ long, filaments with distinct collars developed just below the anther; style branches 2, greatly exserted at maturity, papillose, style glabrous; pappus obsolete or a short lacerate crown; achenes linear-oblong, strongly compressed, 4 angled, setose, setae biseriate; base of achene forming a distinct carpopodium; pollen spherical, tricolpate, very distinctly spinose, ca 25 μ in diameter, spines up to 2 μ long, chromosome number not determined.

Oaxacania malvaefolia B. L. Robinson & J. Greenm. Amer. Journ. Sci. III. **50:** 151. 1895.
[MEXICO: OAXACA: dry cliffs, Tomellin Canyon, 3,000 ft Dec. 22, 1894, *C. G. Pringle* 6117 (Holotype GH!, Isotypes G!; ENCB!; MEXU!; MICH!; MO!; NY!; UC!; US!)]

Additional specimens examined:

MEXICO: OAXACA: Chiltapin; Oaxaca side of Río Santa Lucia, *Purpus* 3084 (F, MO, NY, UC, US); De Almoloyas a Santa Catarena, *Conzatti* 1654 (F, MEXU, US).

Oaxacania bears considerable resemblance to *Carterothamnus* R. M. King, but is clearly distinguished by characters indicated in the following table:

Oaxacania	*Carterothamnus*
achenes flattened	symmetrical achenes
long stalked glands on corolla	corolla glabrous
obsolete pappus	pappus of numerous scales and one long seta
thin hardly expanded tips of the style	thick knoblike tips of the style
small firm cells forming collar at the base of anther	very lax cells forming collar at base of anther

Planaltoa P. Taubert Engl. Bot. Jahrb. **20:** 454. 1896.
(Type species, *Planaltoa salviifolia* Taubert)

Woody shrubs or sub-shrubs. Leaves simple, alternate, sessile. Peduncles not strongly differentiated. Inflorescence polycephalic. Heads turbinate or cylindrical, 4-5 flowered. Phyllaries subequal, in 2-3 series, lanceolate. Corollas slender, tubular, regular, 5 lobed, outer surface with both glands and hairs. Hairs and stalks of glands on corolla often biseriate. Receptacle flat, naked. Anther appendages rather large with slightly reflexed margins. Pollen spherical, tricolpate, distinctly spinose. Style branches elongate, exserted at maturity, narrowly obtuse; basal node of style covered with nonglandular hairs. Pappus lacking. Achenes 5-6 angled, glabrous.

The species of *Planaltoa* may be distinguished by the following key:

1. Leaf blades oblong-elliptical, most hairs of plant with glandular tips, inner surface of corolla glabrous. ..... *P. salviifolia*
1. Leaf blades lanceolate, slightly auriculate, hairs of plant without glandular tips, lobes with shorter uniseriate hairs both on the inner and outer surfaces. ..... *P. lychnophoroides*

Planaltoa salviifolia Taubert, Engl. Bot. Jahrb. **21:** 454. 1896.
[BRAZIL: GOIÁS: Serra dos Pyrenos, 1892-1893, *Ule* 2971 (B, destroyed)]

Plants ca. one meter tall? Stems few-branched, terete. Stems, leaves, phyllaries, and outer surface of corolla covered with dense long pubescence, hairs bearing minute secretory cells apically. Leaves rigid, sessile. Blades oblong-elliptical, 6-10 mm wide, apex obtusely pointed; margins with minute recurved teeth in the upper half. Heads ca 15 mm high (including style branches), ca 4-5 flowered. Phyllaries 5-7, imbricated, in 2-3 series, ca 12 mm long. Florets ca 8 mm long. Lower outer surface of corolla with a few blunt, uniseriate, pitted, nonglandular projections; outer surface with long biseriate hairs bearing minute secretory cells apically, upper ¾ of outer surface with scattered subsessile glands, inner surface of corolla

glabrous. Stamens 5. Anthers (including appendages) ca 3 mm long and 250 μ wide; appendages 250 μ wide and 200 μ long. Style branches papillose, slightly broader apically, exserted at maturity. Achenes prismatic, dark brown at maturity, ca 3 mm long, ca .75 mm wide. Pollen 25 μ in diameter. Chromosome number not determined.

Additional specimens examined:

BRAZIL: GOIÁS: Pirineus, Corumba, *Macedo* 3715 (MO, NY, US); without precise locality, *Glaziou* 21618 (G, GH, US). Without precise locality, *Voyage d' Auguste de Saint-Hilaire de 1816 à 1821* (F).

Planaltoa lychnophoroides G. M. Barroso, Sellowia **17**: 79. 1965.
[BRAZIL: GOIÁS: Cachoeira de Vargem Grande, 1894-95, *Glaziou* 21594. (Holotype G!; Isotype F!)]

Plants ca. one meter tall. Stems branched, terete. Stems, leaves, phyllaries, and outer surface of corolla with dense long nonglandular pubescence. Leaves rigid, sessile, lanceolate, slightly auriculate, 2.5-3.0 cm long, 3.0-5.0 mm wide; lower surface with occasional subsessile glands; margins reflexed, serrate. Heads ca 10 mm high (including style branches), 4-5 flowered. Phyllaries 5-7, imbricated, in two series, ca 10 mm long; outer surface with glands. Florets ca 7-8 mm long. Outer surface of corolla with long uniseriate, nonglandular hairs; lower outer surface of corolla with many biseriate non-glandular setae intermixed with hairs; lobes with shorter uniseriate hairs both on the inner and outer surfaces; subsessile glands sparse on the upper outer surface of corolla. Stamens 5. Anthers (including appendages) ca 2.5 mm long and 450 μ wide; appendages 250 μ wide and 300 μ long. Style branches long-papillose, exserted at maturity. Achenes prismatic, dark brown at maturity, ca 3 mm long, ca .75 mm wide. Pollen 25 μ in diameter. Chromosome number not determined.

Additional specimens examined:

BRAZIL: GOIÁS: 7 km W of Veadeiros, *Irwin, Greer, Souza, Santos* 12909 (MO, TEX, US).

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THE GENUS ACANTHOSPERMUM (COMPOSITAE-HELIANTHEAE-MELAMPODINAE): TAXONOMIC CHANGES AND GENERIC AFFINITIES

TOD F. STUESSY[1]

TAXONOMIC CHANGES

Blake (1921) listed eight good species in his revision of the genus *Acanthospermum*. One year later he himself added two more species to the genus, *A. brachyceratum* and *A. leptolobum*, both from the Galápagos Islands. Another earlier described species, *A. lecocarpoides* (Robinson and Greenman, 1895), was also from these same islands. The genus has stood unchanged with 10 species until just recently Cronquist and Stuessy (*in* Cronquist, 1969) removed the Galápagos species into the related genus *Lecocarpus* based upon total morphology (see Cronquist, 1969, for additional information regarding *Lecocarpus* and these transfers). In the present study based on herbarium material of *Acanthospermum*,[2] *A. donii* is treated as being conspecific with *A. microcarpum* which further reduces the number of species to six. Of the three sections of the genus recognized by Blake (1921), section Lecocarpopsis is now defunct due to removal of the Galápagos species. The following list includes the presently recognized taxa and correct sectional placements:

Section Ceratochlaena DC.
- *A. hispidum* DC
- *A. humile* (Sw.) DC. (photograph of B isotype, TEX!)
- *A. microcarpum* Rob. (holotype, GH!)

[1]Thanks are due Dr. A. Cronquist for helpful suggestions regarding the final manuscript.

[2]Appreciation is expressed to the curators of the following herbaria from which loans of specimens were made (abbreviations after Lanjouw and Stafleu, 1964): ARIZ, F, GH, MICH, NY, SMU, TEX, UC, UPS, US.

A. simile Blake (isotypes, F! NY[2]!; frag. of BM holotype, GH!; photograph of holotype, GH!; photograph of holotype and frag. of K isotype, US!; photograph of F isotype, F!)

Section Acanthospermum (Section Xanthoides DC.)

A. australe (Loefl.) Kuntze

A. consobrinum Blake (frag. of BM holotype, GH!; photograph of holotype, US!).

Blake's sectional characters, key to species, descriptions, and synonymy for these remaining six species of the genus are adequate and are not duplicated here.

Both *Acanthospermum donii* Blake (type probably from Ecuador; frag. of BM holotype, GH!; photograph of holotype, US!) and *A. microcarpum* (type from Galápagos Is.) are known from only a very few collections. After examining available material, I consider the fruit[3] differences (mainly size), emphasized by Blake as specific criteria, to be intergrading and of trivial taxonomic significance. This inclusion removes *A. microcarpum* from the numbers of endemic Galápagos Is. species.

GENERIC AFFINITIES

There are three genera in the Compositae (all subtribe Melampodiinae) that possess vascularized inner involucral bracts each tightly enclosing and fused with a single ray achene: *Acanthospermum*, *Lecocarpus*, and *Melampodium*. Bentham (1873) felt that both "The east tropical *Acanthospermum* and the Galapagian *Lecocarpus* might be included in the widely spread *Melampodium*" (p. 434). As already mentioned, there has been some misunderstanding of the generic limits of *Acanthospermum* and *Lecocarpus*, but *Acanthospermum* and *Melampodium* rarely have been confused. Despite similarities the 3 genera can be distinguished as follows (in part after Bentham and Hooker, 1873, and Hoffman, 1890):

[3]"Fruit" is defined as the ray achene and the enclosing inner involucral bract (Robinson, 1901).

Melampodium	*Acanthospermum*	*Lecocarpus*
(1) Fruit apex hooded or not hooded, sides smooth to tuberculate.	(1) Fruit apex not hooded, sides with straight or hooked prickles.	(1) Fruit apex rimmed with a broad wing or with one to several long prickles, sides smooth.
(2) Leaves entire to variously lobed.	(2) Leaves entire to variously lobed.	(2) Leaves markedly pinnatifidly cleft or divided.
(3) Organs only rarely glandular.	(3) Organs agandular.	(3) Organs markedly glandular.
(4) Plants annual herbs or suffruticose perennials.	(4) Plants annual herbs.	(4) Plants shrubby perennials (annuals?).
(5) Distribution mainly in Mexico and Central America.	(5) Distribution mainly in North and South America (introduced to Old World), one non-endemic species on Galápagos Is. (*A. microcarpum*).	(5) Distribution restricted to Galápagos Is.

The classical distinction between *Melampodium* and *Acanthospermum* has been based mainly on fruits without prickles versus the prickled condition, respectively. However, there is one *Melampodium* species, *M. longifolium*, that possesses "horns" (enlarged apical extensions of the enclosing bract) similar to the apical prickles of *A. simile* and *A. microcarpum*. Nevertheless, this character serves with other characters to successfully delimit the two genera.

Melampodium has been surveyed extensively for chromosome numbers (for a review see Stuessy, 1969) and $n = 10$ is found in the largest number of species in the genus. The few reported counts of *Acanthospermum* are $n = 10$[4] and $n = 11$[5]; these support the presumed close phyletic relation-

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[4]*A. australe*, Carlquist (1954).

[5]*A. hispidum*, Miège (1960, reported as $2n = 22$); *A. australe*, Turner and Irwin (1960) and Coleman (1968).

ship of the two genera. Cytological information regarding *Lecocarpus* is lacking.

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NOMENCLATURE OF THE LUPINUS ARGENTEUS AND L. CAUDATUS COMPLEXES

LLOYD W. HESS[1] AND DAVID B. DUNN

The genus *Lupinus* has long been recognized as one of the very complex groups of plants and the many names published add to the confusion. Among the groups of lupines, the *L. argenteus* complex, which occupies the Great Basin and the Rocky Mountain regions, has been one of the most difficult. Hybridizing studies on this complex were conducted at the Rocky Mountain Biological Laboratory over a five year period. These studies demonstrated that hybridization between the *L. argenteus* and the *L. caudatus* complexes can explain many of the variations which were named and that the two form polymorphic interacting taxa covering much of the same geographic area. The long lists of synonymy add little to the basic understanding of the problem and will be included in the monographic paper in the University Museum Contribution Series. Only the basic names of the group are presented here along with the reasons for the suggested changes in rank. The remaining names of related taxa, in which no change is suggested, are omitted. Since the key to all of the taxa of the group will be in the monograph it is not included in the present paper.

The two complexes presented here are very closely related through introgressive hybridization with *L. caudatus* at the xerophytic extreme and some of the subspecies of *L. argenteus* at the mesophytic extreme. The flower shape of both is very similar with the banner generally reflexed well above the midpoint. There is a patch of pubescence in the central area of the banner on the dorsal side which may be covered by the upper lip of the calyx. In a few taxa this patch of pubescence is absent. There is a well developed spur at the base of the upper lip of the calyx in *L. caudatus*

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and the trait extends into the *L. argenteus* complex. The flowers of the taxa treated here are usually from 8-12 mm long and this separates them from the smaller related *L. parviflorus* complex which will be treated separately. There are 80 synonyms involved in the complete nomenclature so only the basonyms will be cited below.

1. *Lupinus argenteus* Pursh (subsp. *argenteus* var. *argenteus*) Fl. Am. Sept. 2: 468, 1814. Type: Banks of the Kooskoosky, — now considered to be the Clearwater River, *M. Lewis* 4. (Holotype: K, former Lambert Herb.). The closest matching material presently is in Montana, on the eastern base of the Rocky Mountains. The habitat is arid plains and sagebrush from Canada to Arizona.

1a. *Lupinus argenteus* subsp. *argenteus* var. *tenellus* (Dougl. ex. G. Don) Dunn, Leafl. W. Bot. 7: 254, 1955. Type: Vicinity of Grand Rapids of Columbia River, *Douglas* 277. (Holotype: CGE). An outcropping genome, completely sympatric with *argenteus*, the flowers narrow viewed laterally and the leaflets often very narrow. The taxon represents introgression from more xerophytic taxa from another complex. It is more abundant than *argenteus* in the more arid areas but it has not demonstrated dominance of an ecological area.

1b. *Lupinus argenteus* subsp. *rubricaulis* (Greene) Hess & Dunn, comb. nov. Basonym: *L. rubricaulis* Greene, Pl. Baker. 3: 35, 1901. Type: Crested Butte, Colorado, *Baker* 342. (Holotype: ND; Isotypes MIN, MO, RM). The taxon is an altitudinal subspecies associated with montane forests, commonly in the open park areas in the spruce-fir zone but intergrading in numerous places through the Rocky Mountains with *argenteus* or *tenellus* at its lower limits and with *spathulatus* at its upper limits.

1c. *Lupinus argenteus* subsp. *spathulatus* (Rydb.) Hess & Dunn, comb. nov. Basonym: *L. spathulatus* Rydb., Bull. Torr. Bot. Club 29: 204, 1902. Type: Wasatch Mountains in 1869, *S. Watson* 225. (Holotype: NY). The taxon is an-

other altitudinal subspecies at the subalpine zone, commonly growing under and among spruce-fir forests up to timberline. It grades into *rubricaulis* completely and either of the subspecies may simulate the appearance of the other by ecological modification. The broad flat leaflets may be found at lower elevations in shaded areas in aspen groves, while the narrow leaflets may be produced at high elevations in exposed locations. However, there is as much as a month's difference in the flowering times at the different elevations, requiring genetic alterations to accommodate the ecological differences. The material from the type locality appears quite distinct but can be matched by numerous specimens from other areas so that the same process appears to be functional throughout the range of subspecies *spathulatus*.

2. *Lupinus* × *alpestris* A. Nels. Hybridity suggested (*L. caudatus* × *L. argenteus*). Bull. Torr. Bot. Club **26:** 127, 1899. Type: Medicine Bow Mts., Wyoming, prob. Univ. summer camp, *E. Nelson* 5070. (Holotype: RM; Isotype: MO). The original material is closest to subsp. *rubricaulis* but the upper surface of the leaflets is finely pubescent, indicating introgression from *L. caudatus*. The multiple locations where hybridization has taken place have produced a whole range of intermediate forms throughout the geographic region in which *caudatus* and the *argenteus* complex occur. Some of these have become relatively stable intermediates at various levels between the two taxa with numerous names applied by various investigators. In most areas the *argenteus* traits dominate and the taxon is generally sympatric with *argenteus*. However in the Great Basin, where there is greater aridity, the vegetative characistics of *caudatus* prevail, while the floral characteristics of *argenteus* tend to be dominant. It seems preferable to retain the hybrid binomial designation to indicate what is involved, even if the entity is highly variable, rather than reduce it to one of the meaningless varietal names which have been published.

3. *Lupinus caudatus* Hell. (subsp. *caudatus*) Proc. Calif. Acad. **2:** 197, f. 61, 1862. Type: Carson Valley, *Kellogg*.

(Holotype: CAS 62286). Associated with sage brush, extending into the arid pine zones along the east side of the Sierra Nevada Mts. The plants have a densely sericeous hair covering throughout and the upper lip of the calyx has a well developed spur at the base. The spur almost disappears in a clinal gradient eastward to the Laramie area. The genetic markers of ciliation near the claws of the wings and keel, on the margins and laterally, are generally present but become less frequent eastward.

3a. *Lupinus caudatus* subsp. *montigenus* (Heller) Hess & Dunn, comb. nov. Basonym: *L. montigenus* Heller, Muhlenbergia **6:** 109, f. 16, 1910. Type: Mt. Rose, Nevada, *Heller* 9880. (Holotype: RENO; Isotypes: MO, RM, UC). This taxon is viewed as an altitudinal subspecies, restricted to the higher mountains of the east side of the Sierra Nevada Mts. The flowers are the largest of the *caudatus* complex and at the higher peaks have very little development of the calyx spur, with the banner reflexing at the midpoint but the gradation into caudatus at the lower zones appears complete, with the spur becoming very pronounced.

3b. *Lupinus caudatus* subsp. *cutleri* (Eastw.) Hess & Dunn, comb. nov. Basonym: *L. cutleri* Eastw., Leafl. W. Bot. 4: 192, 1945. Type: 18 mi NW Fort Defiance, Arizona, *Cutler* 2141. (Holotype: CAS. Isotypes: DS, MO). This taxon appears restricted to the mountains of the basin area of southeastern Utah, northern Arizona, and northwestern New Mexico. It has predominantly *caudatus* characteristics and appears to intergrade with subspecies *argophyllus* but also appears to have characteristics derived from introgression from an undetermined source.

3c. *Lupinus caudatus* subsp. *argophyllus* (Gray) Phillips, Res. Stud. Wash. St. Coll. **23:** 200, 1955. Basonym: *L. decumbens* Nutt. var. *argophyllus* Gray, Mem. Am. Acad. 4: 37, 1849. Type: Santa Fe, New Mexico, *Fendler*. (Holotype: GH). This taxon is the product of early introgression between *caudatus* and *argenteus*. Floristically the traits

are predominantly those of *caudatus*, with all the characteristic *caudatus* markers, including the ciliation near the claws of the wings and keel, and a well developed spur on the calyx. Vegetatively the characteristics are predominantly those of *argenteus*, including the short petioles, and the leaflets are frequently nearly glabrous above. Subspecies *argophyllus* is quite distinct from any of the material treated as × *alpestris*, and appears to be a stabilized taxon. It does appear to intergrade into *caudatus* in southwestern Colorado.

4. *Lupinus* × *inyoensis* Heller (pro species). Hybridity suggested (*L. caudatus* × *L. palmeri*). Muhlenbergia 2: 211, 1906. Type: Foothills W of Bishop, California, *Heller* 8312. (Isotypes: CAS, ISC, MO, UC). The only suggested change is the insertion of the × to indicate hybrid origin. Three of the four isotypes had spreading hairs, the main trait derived from *palmeri*, while the fourth had the typical appressed hairs of *caudatus* suggesting that the original collection represented a mixed population. In several field population samples made in 1968 in Nevada there were mixed plants of *L. palmeri* and *L. caudatus* with occasional hybrid plants. The population of × *inyoensis* appears restricted to Inyo and Mono Cos., California.

The authors wish to express their appreciation to the curators of the several herbaria indicated in the text by the codes designated in Index Herbariorum. Citations of their specimens will be in the monograph. Appreciation is also expressed to Rocky Mountain Biological Laboratory for the use of their facilities in summer.

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FLORA OF THE WOLF ISLANDS PART III: THE MARINE ALGAE

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The vascular plants of the Wolf Islands have been investigated thoroughly by A. R. Hodgdon and R. B. Pike (Rhodora, 65:82-96, 364-365, 1963; 66:61-62, 140-155, 413-416, 1964; 71:297-302, 1969). At their suggestion we have undertaken a floristic study of the marine algae of these islands.

We have made three visits (4 June and 13 August, 1968 and 22 February, 1969) to South Wolf Island, as it affords the most accessible intertidal regions. Numerous small coves offer a variety of protected habitats. However, most of the coast is exposed. There is a great expanse of intertidal region — the average tidal amplitude is about 17 feet.

Ninety-one taxa are recorded from South Wolf Island, including 27 Chlorophyceae, 26 Phaeophyceae and 38 Rhodophyceae. This compares with 114 taxa recorded from Campobello Island during a three year study (Stone, et al., in press). Future trips will include the other Wolf islands and may yield additional species.

The algae were collected and preserved in a brine solution for laboratory identification and processing. Voucher specimens are deposited in the Herbarium of the University of New Hampshire and Southampton College, Long Island, New York. The nomenclature of Parke and Dixon (1968) has been applied in most cases, except for the Acrochaetiaceae (Papenfuss, 1947).

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CHECKLIST

CHLOROPHYCEAE:

Chaetomorpha melagonium (Weber *et* Mohr) Kützing
Codiolum gregarium A. Braun
C. petrocelidis Kuckuck
C. pusillum (Lyngbye) Kjellman
Epicladia flustrae Reinke
Enteromorpha groenlandica (J. Agardh) Setchell *et* Gardner
E. intestinalis (L.) Link
E. linza (L.) J. Agardh
E. marginata J. Agardh
E. micrococca Kützing
E. minima Nägeli
Monostroma fuscum (Postels *et* Ruprecht) Wittrock forma *blyttii* (Areschoug) Collins
M. grevillei (Thuret) Whittrock
M. leptodermum Kjellman
M. pulchrum Farlow
Prasiola stipitata Suhr in Jessen
Pseudendoclonium marinum (Reínke) Aleem *et* Schulz
Rhizoclonium riparium (Roth) Harvey var. *implexum* (Dillwyn) Rosenvinge
R. tortuosum Kützing
Spongomorpha arcta (Dillwyn) Kützing
S. lanosa (Roth) Kützing
S. spinescens Kützing
Ulva lactuca L.
Urospora collabens (C. Agardh) Holmes *et* Batters
U. penicilliformis (Roth) Areschoug
U. speciosa (Carmichael) Leblond *et* Hamel
U. wormskjoldii (Mertens in Hornem) Rosenvinge

PHAEOPHYCEAE:

Agarum cribrosum (Mertens) Bory
Alaria esculenta (L.) Greville
Ascophyllum nodosum (L.) Le Jolis
Asperococcus echinatus (Mertens) Greville
Chorda tomentosa Lyngbye
Chordaria flagelliformis (O. F. Müller) C. Agardh
Desmarestia aculeata (L.) Lamouroux
Dictyosiphon foeniculaceus (Hudson) Greville
Ectocarpus confervoides (Roth) Le Jolis
Elachista fucicola (Velley) Areschoug
Fucus distichus L. ssp. *distichus* Powell
F. distichus L. ssp. *edentatus* (de La Pylaie) Powell

F. distichus L. ssp. *evanescens* (C. Agardh) Powell
F. spiralis L.
F. vesiculosus L.
Isthmoplea sphaerophora (Carmichael) Kjellman
Laminaria digitata (Hudson) Lamouroux
L. longicruris De la Pylaie
L. saccharina (L.) Lamouroux *sensu* Wilce
Leathesia difformis (L.) Areschoug
Myrionema strangulans Greville
Petalonia fascia (O. E. Müller) Kruntze
Pilayella littoralis (L.) Kjellman
Ralfsia fungiformis (Gunnerus) Setchell *et* Gardner
Scytosiphon lomentaria (Lyngbye) Link
Sphacelaria cirrosa (Roth) C. Agardh

RHODOPHYCEAE:

Ahnfeltia plicata (Hudson) Fries
Antithamnion cruciatum (C. Agardh) Nägeli
A. floccosum (Müller) Kleen
Audouinella membranacea (Magnus) Papenfuss
Bangia fuscopurpurea (Dillwyn) Lyngbye
Ceramium deslongchampsii Chauvin in Duby var. *hooperi* (Harvey) Taylor
C. rubrum (Hudson) J. Agardh
Chondrus crispus Stackhouse
Choreocolax polysiphoniae Reinsch
Clathromorphum circumscriptum (Strømfelt) Foslie
Corallina officinalis L.
Cystoclonium purpureum (Hudson) Batters
Euthora cristata (C. Agardh) J. Agardh
Gigartina stellata (Stackhouse) Batters
Halosaccion ramentaceum (L.) J. Agardh
Hildenbrandia prototypus Nardo
Kylinia alariae (Jónsson) Kylin
K. secundata (Lyngbye) Papenfuss
Lithophyllum corallinae (Crouan frat.) Heydrich
Lithothamnium glaciale Kjellman
Membranoptera alata (Hudson) Stackhouse
Petrocelis middendorfii (Ruprecht) Kjellman
Peyssonelia rosenvingii Schmitz in Rosenvinge
Phycodrys rubens (L.) Batters
Phymatolithon lenormandi (Areschoug) Adey
Plumaria elegans (Bonnemaison) Schmitz
Polyides rotundus (Hudson) Greville
Polysiphonia lanosa (L.) Tandy
P. urceolata (Lightfoot *ex* Dillwyn) Greville

Porphyra leucosticta Thuret in Le Jolis
P. linearis Greville
P. miniata (C. Agardh) C. Agardh
P. umbilicalis (L.) J. Agardh
P. umbilicalis (L.) J. Agardh f. *epiphytica* Collins
Ptilota serrata Kützing
Rhodochorton purpureum (Lightfoot) Rosenvinge
Rhodomela confervoides (Hudson) Silva
Rhodymenia palmata (L.) Greville

ACKNOWLEDGEMENTS

The authors wish to thank Dr. A. C. Mathieson for his assistance in the identification of several plants; Radcliffe and Sumner Pike for their hospitality and generosity which made this study possible. We are grateful to Drs. A. R. Hodgdon and R. B. Pike for financial support for travel from the "Wolf Island Fund" throughout this study.

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A SYNOPSIS OF THE GENUS SUESSENGUTHIA (ACANTHACEAE)

DIETER C. WASSHAUSEN

During the course of routine identifications of Acanthaceae from South America, I have found two undescribed species of the genus *Suessenguthia* Merxmüller. In an attempt to make proper placement of the species, the monograph of *Sanchezia* and related genera (Leonard & Smith, 1964) was used. In this paper *Sanchezia leucerythra* was described as a new species. After examining the type, its four fertile appendaged stamens indicate that it should be transferred to the genus *Suessenguthia*. The two new species are described and the new combination is made. A key is also provided. The loan of material from the New York Botanical Garden is gratefully acknowledged.

SUESSENGUTHIA

H. Merxmüller, Mitteilungen der Botanischen Staatssammlung München [1], Heft 6: 178, pl. 1953. (Type species, *Suessenguthia trochilophila* Merxm.)

Shrubs; stems erect, quadrangular, sulcate; leaves opposite, short-petioled, cystoliths conspicuous; flowers solitary or fascicled, usually large and conspicuous, borne in heads, spikes or cymes, the flower cluster subtended by small or often large and partly connate bracts, these sometimes colored; calyx 5-parted, the segments subequal; corolla lilac or red, the tube cylindric, 5-lobed, the lobes equal; stamens 4, the longer two exserted, the shorter two included or barely reaching the throat of the corolla; anthers 2-celled, longitudinally ciliate, mucronate at base; ovary disc minute, sessile; style glabrous; ovules 4 per locule.

The species of *Suessenguthia* can be distinguished by the following key:

a. Inflorescence capitate or cymose.
   b. Inflorescence capitate; bracts ovate, acuminate, corolla minutely pubescent ..... 1. *S. leucerythra*
   b. Inflorescence cymose; bracts obovate, caudate; corolla densely sericeous ..... 2. *S. vargasii*

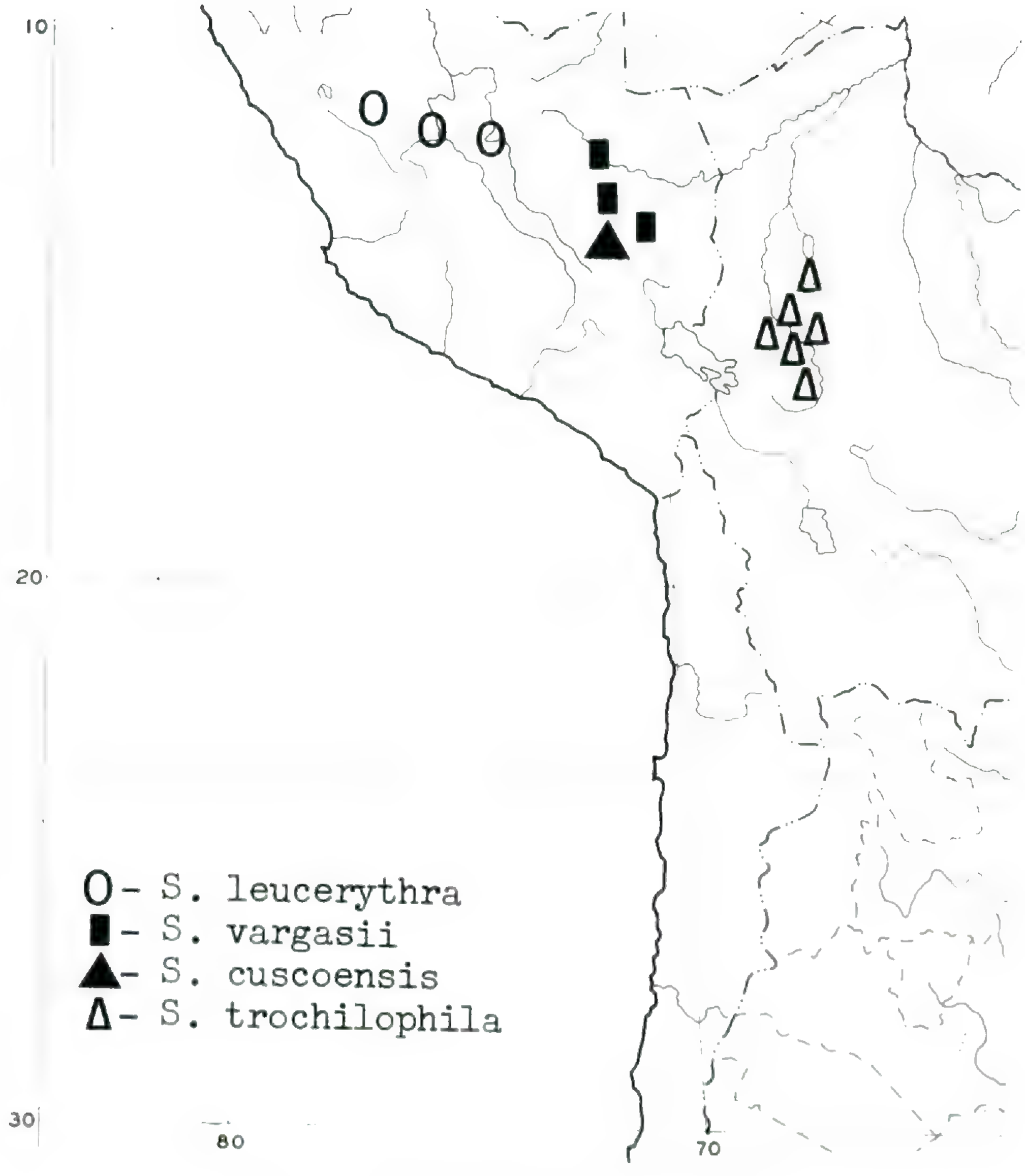

Fig. 1. Distribution of *Suessenguthia.*

a. Inflorescence spicate.
   c. Fascicles all sessile in elongated spikes; bracts subtending the floral cluster elliptic ..... 3. *S. cuscoensis*
   c. Basal fascicles of flowers pedunculate; bracts subtending the floral cluster triangular-cuspidate ..... 4. *S. trichilophila*

1. **Suessenguthia leucerythra** (Leonard & Smith) Wasshausen, comb. nov. *Sanchezia leucerythra* Leonard & Smith, Rhodora **66**: 318. 1964.

PERU: Junín: dense forest near Perene Bridge, Río Paucartambo Valley, 700 m, June 19, 1929, *E. P. Killip & A. C. Smith* 25271 (Holotype NY!).

Shrub 2-5 m tall, stem quadrangular, glabrous, sulcate; leaf blades lanceolate, up to 18 cm long and 5 cm wide, acuminate, the tip itself obtuse, the upper surface glabrous, minutely papillose, cystoliths numerous, 0.25 mm long, on the lower surface the costa and lateral veins (ca 8 pairs) conspicuous, pilose, the hairs appressed, the margins short repand-crenate; petiole up to 2 cm long, appressed-pilose; inflorescence capitate, 3.5 cm long, 3 cm wide; lowermost bracts lanceolate, up to 4.5 cm long, 1.5 cm wide, acuminate, pilose, the hairs appressed, 0.5 mm long, bracts subtending the flower cluster ovate, 3 cm long, 1.3 cm wide, acuminate, sericeous, the hairs appressed and 1 mm long, distally deep pink-purple, basally white; bractlets 3 cm long, 1 cm wide, acuminate, sericeous, the hairs appressed, 0.5 mm long, brown; calyx segments 27-30 mm long, 2-6 mm wide, subequal, linear-lanceolate, slender-acuminate, sericeous; corolla pale red, basally white, 4-4.5 cm long, basally 3-5 mm wide, 10 mm wide at throat, minutely pubescent with recurved hairs, the lobes ca 10-15 mm long, broadly rounded and short-emarginate, erect, densely retrorsely pubescent; stamens 4, cream white, the two longer exserted 7-10 mm beyond the throat of the corolla, the two shorter included and barely reaching the throat of the corolla; ovary pilose; fruit not seen.

OTHER SPECIMENS EXAMINED: PERU: Junín: open place in forest, Río Negro, 800 m, August 14, 1960, *F. Woytkowski* 5794 (US); Cusco: Prov. de La Convencion, "Subiendo a Ichigurato; Alto Urubamba", April 16, 1966, *C. Vargas C.* 17235 (CUZ, US).

2. **Suessenguthia vargasii** Wasshausen, sp. nov.

PERU: Cusco: Prov. de Quispicanchis, forest, between Quince Mil and San Lorenzo, 700 m, July 25, 1957, *C. Vargas C.* 11732 (Holotype US! Isotype CUZ).

Frutex, caulibus quadrangularibus; folii lamina oblongo-elliptica acuminata, apice curvata, basi angustata, glabra, integra vel undulata, costa et venis prominentibus; inflorescentia pauciramosa, cymosa, floribus in fasciculis;

bracteae obovatae, caudatae, sericeae; bracteolae anguste oblongae, acuminatae; calycis segmenta lanceolata vel oblanceolata, subaequalia, sericea; corolla pallide rubra, dense sericea, lobis late rotundatis et leviter emarginatis; stamina 4, longiora exserta, breviora sub-exserta; ovarium dense sericeum.

Shrub 2-5 m tall, stem quadrangular, glabrous, sulcate; leaf blades oblong-elliptic, 10-16 cm long, 3.5-5 cm wide (the lowermost probably larger), gradually narrowed to a slender curved apex (the tip blunt), narrowed at base, glabrous, entire or undulate, the costa and lateral veins (6 to 8 pairs) prominent beneath; petioles 5-12 mm long, connate at base by a small ridge or narrow band of leaf tissue; flowers borne in fascicles in a few-branched cymose inflorescence, 4 cm long, 2 cm wide; lowermost bracts obovate, up to 2 cm long, 1.3 cm wide, caudate, sericeous, the hairs appressed, yellowish; bracts subtending the flower cluster obovate, up to 3 cm long, 1.3 cm wide, caudate, densely sericeous, the hairs appressed, yellow; bractlets narrowly oblong, 3 cm long, 7 mm wide, acuminate, densely sericeous, the hairs appressed, distally deep pink purple; calyx segments up to 30 mm long, subequal, 4-5 mm wide, lanceolate to oblanceolate, slender-acuminate, sericeous; corolla drying pale red, 4-6 cm long, basally 4 mm wide, 8 mm wide at throat, densely sericeous with appressed hairs, these 2.5 mm long, the lobes 10-15 mm long, broadly rounded and short-emarginate, erect or spreading, sericeous, the hairs spreading; stamens 4, the longer two exserted, the shorter two barely reaching the throat of the corolla; style 5 cm long, glabrous; ovary densely sericeous; fruit not seen.

OTHER SPECIMENS EXAMINED: PERU: Cusco: Prov. de Paucartambo, forest, Kosñipata, between Pilcapata — Atalaya, 450-550 m, August 5, 1956, *C. Vargas C.* 11289 (CUZ, US); Madre de Dios: Prov. de Manu, "Synduya?", 400 m, October 6, 1966, *C. Vargas C.* 17831 (CUZ, US).

3. **Suessenguthia cuscoensis** Wasshausen, sp. nov.

PERU: Cusco: Prov. de Paucartambo, forest, Kosñipata, between Pilcapata — Atalaya, 450-550 m, August 5, 1956, *C. Vargas C.* 11288 (Holotype US! Isotype CUZ).

Frutex, caulibus quadrangularibus pilosis sulcatis; folii

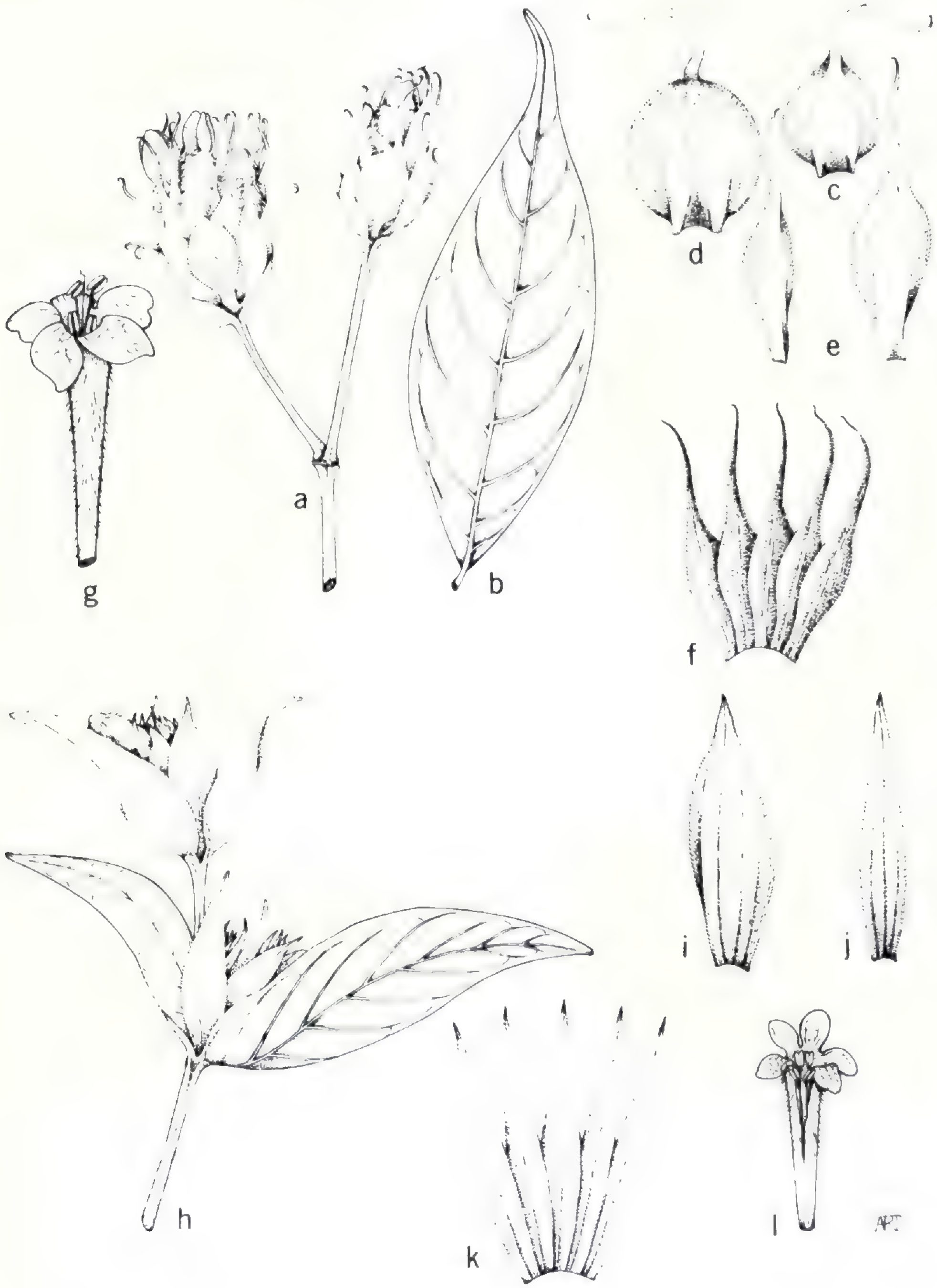

Fig. 2. *Suessenguthia vargasii* (a-f): a — inflorescence × ½; b — leaf blade × ½; c — lowermost bract × 1; d — bract × 1; e — bractlets × 1; f — calyx × 1; g — corolla × ½; *Suessenguthia cuscoensis* (h-l): h — inflorescence × ½; i — bract × 1; j — bractlet × 1; k — calyx × 1; l — corolla × ½.

lamina elliptica acuminata, apice ipso obtuso, ad basim in petiolum decurrens, supra glabra, subtus parce pilosa costa et venis lateralibus obscuris; spicae terminales et axillares, floribus pluribus in fasciculis sessilibus congestis; bracteae ellipticae, acuminatae, parce sericeae; bracteolae lanceolatae, acuminatae, parce sericeae; calycis segmenta lanceolata, subaequalia, parce sericea; corolla laete rubra sericea, lobis late rotundatis et leviter emarginatis; stamina 4, vix exserta; ovarium dense sericeum.

Shrub 2-5 m tall, the stem quadrangular, sulcate, pilose, the hairs appressed; leaf blades elliptic, up to 16 cm long and 7 cm wide (the lowermost probably larger), acuminate, the tip itself obtuse, attenuate at base and decurrent on the petiole, firm, the upper surface glabrous, minutely papillose, cystoliths numerous, on the lower surface the costa and lateral veins rather inconspicuous, sparingly pilose, the hairs appressed, the margins short repand-crenate; petioles up to 1.5 cm long, connate at base by a small ridge or narrow band of leaf tissue; flowers borne in sessile fascicles in axillary and terminal spikes, these lax, internodes 2-3 cm long, sericeous, the hairs appressed; lowermost bracts ovate, 3-9 cm long, 1.5-2.5 cm wide, acuminate, thinly sericeous, the hairs appressed; bracts subtending the flower cluster elliptic, 2.8-3.5 cm long, 0.7-1.3 cm wide, acuminate, thinly sericeous, the hairs white, appressed, 1 mm long; bractlets lanceolate, 2.3 cm long, 4 mm wide, acuminate, thinly sericeous, the hairs appressed; calyx segments lanceolate, 1.8 cm long, subequal, 3-4 mm wide, acuminate, thinly sericeous, the hairs white, appressed; corolla drying pale red, 4 cm long, basally 3 mm wide, 7 mm wide at throat, sericeous with appressed hairs 1 mm long, the lobes 7-9 mm long, broadly rounded and short-emarginate, erect, sericeous, the hairs appressed; stamens 4, barely exceeding the throat of the corolla; style glabrous; ovary densely sericeous; fruit not seen.

4. *Suessenguthia trochilophila* Merxm. in Mitteil. Bot. Staatss. München [1], Heft 6: 178, *pl. 1953;* Rhodora **66:** 343. 1964.

BOLIVIA: at the foot of the Andes near Rurrenabaque, on the right bank of the Rio Beni, September 23, 1951, *G. Niethammer* 208 (Holotype M).

Shrub 1.5-2 m tall, stem quadrangular, sulcate, glabrous; leaf blades broadly lanceolate, up to 25 cm long and 10 cm wide, subacute, basally narrowed and decurrent on the petiole, firm, the upper surface glabrous, minutely papillose, cystoliths numerous, on the lower surface the costa and lateral veins (ca 8-10 pairs) prominent, the margins repand-crenate; petioles up to 1.5 cm long, connate at base by a small ridge or narrow band of leaf tissue; flowers borne in sessile fascicles in terminal 2-3-branched spikes, these lax, the internodes 1.5-2.5 cm long, sparingly sericeous, the hairs spreading; lowermost bracts broadly ovate, 2-2.5 cm long, 1.5-2 cm wide, acuminate, glabrous or very sparingly sericeous; bracts subtending the floral cluster triangular-cuspidate, 2.6-2.8 cm long, 1-1.3 cm wide, sparingly pilose, the hairs appressed, 1 mm long; bractlets narrowly lanceolate or subulate, 1.8 cm long, 4 mm wide, long acuminate, thinly sericeous, the hairs appressed; calyx segments lanceolate, subequal, 2.2-2.4 cm long and 0.3-0.5 cm wide, acuminate, thinly sericeous, the hairs white, appressed; corolla rose-lilac, 4.5 cm long, basally 3 mm wide, 1 cm wide at throat, glabrous, the lobes 12 mm long, apically rounded, spreading not revolute, glabrous; stamens 4, the two longer sub-exserted, the two shorter included in the corolla tube; style 3.7 cm long, long exserted, glabrous; ovary ovate, apically pilose; fruit not seen.

OTHER SPECIMENS EXAMINED: BOLIVIA: Beni: Rurrenabaque, 300 m, November 1921, *H. H. Rusby* 850 (NY, US); La Paz: [illegible] sand near river, in shade, near Coroico, Yungas, August 2, 1894, *M. Bang* 2367 (GH, NY, US); Guanai, 600 m, May 1886, *H. H. Rusby* 1119 (US); woods, San Carlos, Mapiri, 700 m, August 1907, *O. Buchtien* 1403 (NY, US); San Bartolome (near Calisaya), basin of Río Bopi, Prov. S. Yungas, 750-900 m, July 1929, *B. A. Krukoff* 10186 (US); Asunta (near Evenay), Prov. S. Yungas, 690-750 m, July 1939, *B. A. Krukoff* 10585 (US).

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM, WASHINGTON, D.C. 20560

Stuart Kimball Harris outside of Lake of Clouds Hut of Appalachian Mountain Club on Spring Flower Walks, June 1967. Photograph taken by Wesley N. Tiffney. The peruvian type headgear was made by Dr. Harris.

STUART KIMBALL HARRIS

Again the New England Botanical Club has lost one of its most active members. Stuart Kimball Harris died July 30, 1969, after a sickness of several months. The Club misses a comrade and friend who was always willing to help, and a fellow-worker in its many different activities. He is survived by his wife, Calista Crane Harris, a daughter, Sally, a son, Kimball, and two grandchildren.

Dr. Harris was born in Haverhill, Massachusetts, the son of Hayden B. and Vina Harris. After High School he went to Boston University from which he received three degrees, a Bachelor of Business Administration in 1927, Bachelor of Science in 1930, and Master of Arts in 1932. Evidently his life-interest began to assert itself and he earned at Harvard University an M.A. and under Prof. Fernald a Ph.D. in 1936 in the field of Botany.

He wrote more than forty botanical papers, earlier on lichens, and later on the flowering plants. Several of these professional papers he edited and they were later published by the Appalachian Mountain Club as the principal text of the book, "Mountain Flowers of New England" in 1964. Through his careful proof-reading and editing, the revision of Prof. Pease's "Flora of Northern New Hampshire" was published in 1964. Since its publication Dr. Harris had collected extensively in northern New Hampshire to add new localities to those which Prof. Pease had, as well as species not before listed in the area.

For many years he had been collecting data to add to a revision of Robinson's "Flora of Essex County, Massachusetts" which material was practically ready for publication. Another of his botanical projects was a check-list of the plants of Rockingham County, New Hampshire, giving the species, where and when it was found and by whom.

Dr. Harris had been a member of the New England Botanical Club since 1930 and spent many hours in the study and identification of plants not only from New England but from all over the United States and even some

from Honduras and Mexico. He travelled extensively and always brought back a good lot of plants to be worked over. He was repeatedly in California and other western states. One fruitful trip was to the Big Bend area in Texas. In 1944 he joined a scientific expedition to Alaska by the Alcan Highway where he served as cook.

He was a Member of the Plant Distribution Committee of the New England Botanical Club whose reports appear in Rhodora from time to time. He was for thirty three years an Associate Editor of Rhodora, the publication of the New England Botanical Club. He personally contributed plants both to the herbarium of the New England Botanical Club and to the Gray Herbarium, and supervised their identification. He was also Recording Secretary of the Club from 1935 to 1964 and was President at the time of his death.

Dr. Harris was for 36 years a member of the Faculty of the College of Liberal Arts of Boston University where he taught courses in Biology but was happiest and at his best in the botany courses, especially with the upper class men and the graduate students where his stimulating and enthusiastic teaching was greatly appreciated. He was always ready and willing to help and advise students outside the classroom.

As already indicated, Dr. Harris was far from what some scientists disparagingly called "a closet botanist." His interest and energy were evident in his years of association with the Appalachian Mountain Club. From the beginning as hutman at Lake of the Clouds, he went on to become the Club Naturalist and for a number of years he led the annual Spring Flower Tours in the Presidential Range. In all his walks and tours he remained enthusiastic and tireless.

Another phase of his interest in Natural History until his last illness was the study and identification of birds. He revised the most recent edition of the "Field List of the Birds of Essex County, Massachusetts". During his active membership in the Essex County Ornithological Club he held various offices including the presidency. For over

thirty years he joined in the annual Club canoe trip on the Ipswich River. He belonged to the Nuttall Club of Cambridge, the oldest ornithological club in the United States, and the Massachusetts Audubon Society. For a number of years he made a Christmas bird count in the vicinity of his camp in northern New Hampshire, which was published by the National Audubon Society. This count was made whatever the weather conditions. Also on most days when he was at home he took an extensive bird walk before he drove to Boston. All this led him to take an active interest in the Ipswich River Sanctuary of the Massachusetts Audubon Society where he served on the Development Committee. He was a member and past chairman of the Conservation Commission in the town of Boxford where he made his home. There he worked to preserve the beauty of the woods, fields, ponds and streams.

As if these activities were not enough to make use of his leisure time, he had other interests to which he gave real thought and careful planning. He was an enthusiastic silversmith and also did worthwhile work in weaving. Even in the last weeks before he had to give up much activity, he came to the Gray Herbarium and worked on the identification of his last summer's collections.

He will be sorely missed in many places and by many friends. His work for the New England Botanical Club must command the greatest respect. There are many who enjoy one avocation but Dr. Harris was interested and active in many phases of Natural History beside Botany.

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BAYARD LONG (1885-1969)

Bayard Henry Long was born on September 22, 1885, and died on June 9, 1969. His father was John Luther Long, a Philadelphia lawyer who was born and raised in Hanover, York County, Pennsylvania.

The elder Long's sister had gone as a missionary to Japan in the early 1890's and had married the Rev. J. H. Correll. A few years later the Corrells returned to Philadelphia where Bayard's father had established a law practice. Over dinner one evening the Corrells related to Long the story of an American naval officer who had married a geisha girl in Nagasaki. Such marriages were then considered temporary arrangements, which could easily be annulled. The bride in this case who had given birth to a child, took a different view of the matter and, when her "husband" returned to Japan with his American wife, killed herself.

John Luther Long, who had turned to writing as a sideline, added a few embellishments to this story and it was published in the Century Magazine in 1898. Later David Belasco adapted it as a play which was a success on Broadway in 1900 and at Belasco's suggestion Giacomo Puccini used the story as the basis for his opera "Madame Butterfly" which is recorded as a failure in its premiere in Milan in 1904, but later, after revision, became a great success and is still a standard offering in the repertoire of the worlds great opera companies.

The elder Long had established himself as a novelist and playwright and one of his most successful achievements was "The Darling of the Gods" produced by Belasco and starring Blanche Bates. Long died October 31, 1927.

Very little is known of the early years and young manhood of John Luther Long's son, Bayard. We know that he attended Cheltenham High School, not far removed from his father's house in Ashbourne (now Elkins Park), a suburb of Philadelphia, and that upon his graduation in 1904 he was the Orator of his class. He then attended the Uni-

Bayard Long, Hampden Lake, New Jersey, August 1940.

versity of Pennsylvania, where he majored in Botany and in June, 1908, was awarded the degree of Bachelor of Science in Biology. He later registered in Graduate School of Arts and Sciences at the University, but apparently did not receive a graduate degree.

Just when Bayard Long became affiliated with the Philadelphia Academy of Natural Sciences the Academy's records do not reveal, but it was probably while he was still taking courses in Botany at the University. We know that he became a member of the Philadelphia Botanical Club in 1906 and that in 1913 he was elected Curator of the Club's Local Herbarium, a position to which he was annually re-elected until the year of his death. Thus, his custodianship of one of the country's finest local herbaria spanned an interval of 56 years. At no time during his career did Bayard accept any salary from the Academy.

The Philadelphia Botanical Club had been founded in December, 1891, by a group of amateur botanists who were enthusiastically devoted to studying the flora of the Philadelphia local area. By their definition this area comprised all of southern New Jersey and southeastern Pennsylvania, as well as Harford County, Maryland and New Castle County, Delaware.

For many years members of the Club explored and collected in the numerous plant habitats included in this area, e.g; the Pine Barrens of New Jersey, the glaciated portions of Northampton County, the serpentine outcrops of Chester and Lancaster Counties, etc. Long was a frequent member of these expeditions and early demonstrated his keenness as an observer and his superb ability as a collector.

The early issues of *Bartonia*, the official publication of the Club, were filled with accounts of the exciting finds made on these trips and the cases in the Local Herbarium (housed at the Academy) were soon bulging with specimens from all corners of the local area.

It is doubtful that anyone ever possessed a higher standard for the quality of an herbarium specimen than Bayard Long. Every leaf had to be laid out flat, every inflorescence

properly displayed, every flower part clearly shown. Extra flowers and loose fruits and seeds were placed in pockets affixed to the sheet. Root systems (collected in their entirety whenever possible) were scrupulously clean, habitats were accurately described and localities were identified to the nearest tenth of a mile and closest compass point. All of this seems the more remarkable when it is realized that Long collected close to 80,000 numbers, not including collections made as a member of Fernald's expeditions.

It was inevitable that a man of Long's keen intelligence and critical judgement should come to the attention of Professor M. L. Fernald. In 1911 Fernald wrote, "since Mr. Long has on other occasions shown keen discrimination in his study of the Cyperaceae, it is a pleasure permanently to associate his name with the new *Scirpus Longii* n.sp." (Rhodora 13. 6. 1911) During the years that followed Fernald named nine other species in Long's honor.

Between July 2 and September 9, 1920, Long joined the Gray expedition under Fernald to Nova Scotia (see Rhodora 23: 94. 1921) and in 1924 and 1925 he was a member of the party which explored Newfoundland. It was in his "Journal of the Summer of 1925" that Fernald stated, "If there is a keener collector or discoverer of native plants than Bayard Long, I have yet to meet him". (Rhodora 28: 94. 1926.)

I first met Bayard Long in the autumn of 1921. At that time I had had no formal training in botany, but was beginning to be interested in plants and was attempting to identify the species that I encountered in the suburbs of Philadelphia. I had purchased a copy of the 7th edition of Gray's Manual and found it rather hard going. In desperation I took some of my puzzles in to the Academy of Natural Sciences and inquired of a guard where I would find a botanist. I was directed to the Herbarium of the Philadelphia Botanical Club. There I met Mr. Long who quickly solved my problems, encouraged me to continue collecting and advised me to join the Philadelphia Botanical Club, which I promptly did. Thus began an association which

lasted for more than 40 years — a friendship cemented by countless field trips in the local and more distant areas.

As an undergraduate student in the early 20's I had become fascinated by the writings of M. L. Fernald and had read every word he had published in the pages of Rhodora. In particular was I excited by the accounts of his expeditions to New Brunswick, the Gaspé Peninsula, Nova Scotia and Newfoundland. I begged Long, who had already been on several of these trips, to ascertain whether there would ever be an opportunity for me to become a member. It was entirely through his intercession that Professor Fernald invited me to join Long and him on a brief excursion to Newfoundland in 1926.

This was the summer of the Fourth International Congress at Ithaca, so we were unable to leave for Newfoundland until late in August. Three years later, in the summer of 1929, I was again privileged to join Fernald (with whom I had now taken my Doctor's degree) and Long on a much longer tour.

The events of these two trips were summarized by Fernald in an article entitled, "Recent Discoveries in the Newfoundland Flora", which occupied all twelve numbers of Rhodora for 1933 (Vol. 35).

In the 1930's I accompanied Fernald and Long on two collecting trips to the Coastal Plain of southeastern Virginia. The results of these trips were also published by Fernald in Rhodora.

Bayard Long's intellectual qualifications were such that he could doubtless have succeeded in any field of endeavor which appealed to him. He was an ardent philatelist, his specialty being British Colonies, a subject area which calls for keen powers of observation. His tastes in literature and music were exalted and he had a deep appreciation of natural beauty.

With it all Long was an extremely modest and almost painfully self-effacing individual. He appeared to shrink from human contacts, but once convinced of a person's sincere desire to learn, no effort was too great, no demands

on his time too exacting for him to render assistance and share his prodigious knowledge. Certainly no one has ever possessed his intimate acquaintance with the local flora, but he was equally at home in the field in Newfoundland and Virginia.

Long's first serious illness occurred in the early 1960's, although he continued to work at the Academy until the fall of 1962. Afterwards he was confined to his home in Elkins Park, where almost until the very end he continued by letter and telephone to answer the questions of those who called upon him for help.

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2. *Pinus serotina* Michx. in southern New Jersey and other local notes. Bartonia. **2**:17-21. 1910.
3. Certain species becoming well established at Ashbourne and elsewhere near Philadelphia. Bartonia. **3**:22-25. 1911.
4. *Galium labradoricum* in Pennsylvania. Rhodora. **14**:199, 1-200. 1912.
5. Some results of recent field work in the Cape May peninsula. Bartonia. **4**:14-19. 1912.
6. Range extension in *Antennaria*. Rhodora. **15**:117-122. 1913.
7. *Ludwigiantha brevipes* Long n.sp. Britton & Brown Illus. Flora Ed. 2. II:586. 1913.
8. (With Fernald) The American variations of *Potentilla palustris*. Rhodora. **16**:5-11, *pl. 106*. 1914.
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24. Some changes in the aspect of the list of the Philadelphia flora. Bartonia. **8**:12-32. 1924.
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PLANTS NAMED FOR BAYARD LONG

Scirpus Longii Fernald, Rhodora **13**:6-8. 1911.
Cardamine Longii Fernald, Rhodora **19**:91. 1917.
Carex Longii Mackenzie, Bull. Torrey Bot. Club **29**:373. 1923.
Braya Longii Fernald, Rhodora **28**:202. 1926.
Antennaria Longii Fernald, Rhodora **28**:237. 1926 (1927).
Bryum Longii E. B. Bartram, Rhodora **30**:6, 7. 1928.
Antennaria Bayardi Fernald, Rhodora **38**:402. 1936.
Lycopus americanus Muhl., var. *Longii* Benner, Bartonia **16**:46. 1934 (1935).
Malaxis Bayardi Fernald, Rhodora **38**:402. 1936.
Juncus Longii Fernald, Rhodora **39**:397. 1937.
Rubus Longii Fernald, Rhodora **40**:434. 1938.
Carex Bayardi Fernald, Rhodora **44**:71. 1942.
Xyris Bayardi Fernald, Rhodora **48**:56. 1946.

In the preparation of this account I have been greatly assisted by Dr. E. T. Wherry and Mrs. Nellie Erisman.

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BOOK REVIEW

IMPORTANT WORK ON THE FLORA OF NEW ENGLAND[1]

A. R. HODGDON

The experience of having used Seymour's "Flora of New England" rather constantly for over a year has provided this reviewer with an unusual awareness of both the strengths and weaknesses of the book. At present, when dealing with New England plants, I am inclined to rely nearly as much on Seymour's "Flora" as on Fernald's 8th edition of Gray's Manual. This is not to say that it replaces the "Manual", but it does supplement it nicely in certain particulars and in nomenclature tends to bring the older book up to date for New England.

"The Flora of New England", as indicated in the subtitle, is more than a flora in that it has keys to genera and species and brief diagnoses of families and genera, thus making it available as a laboratory text for college classes dealing with New England plants. In this respect, then, it is a "Manual".

Blake and Atwood (Geographical Guide to Floras of the World, Part I, U. S. Dep. Agr., Misc. Publ. 401, 1942, pp 8-9) have made some suggestions concerning the kinds of information to be included in a "flora", many but not all of which have been satisfactorily followed by Seymour. In addition it would have been desirable, for an area so long worked over as New England, to include a listing, perhaps only a selected one, of the local floras of the region, particularly since many of these provide additional and much more detailed information about the occurrences of plants locally. For example, it seems neglectful not to have listed the admirably complete "Flora of Northern New Hampshire" by Arthur Stanley Pease.

---

[1]The Flora of New England. A Manual for the Identification of all Vascular Plants including Ferns and Fern Allies and Flowering Plants growing without Cultivation in New England, by Frank Conkling Seymour. Charles E. Tuttle Co., Rutland, Vermont, 1969. xvi + 596 pp. illus. $12.50.

Unfortunately, the "profit motive" has to be a prime consideration in the preparation of a "flora". In order to "sell" the book has to be kept within certain limits of size, and has to be useful to a variety of persons such as college students in botany courses. Recent state floras and now this regional flora reflect a trend to incorporate in them keys, brief descriptions and numerous illustrations as well. It certainly is often in order for a flora to provide in one package a body of information relating to the places where taxa are to be found along with the means to identify and recognize these taxa. But to do both of these tasks well or even passably well for an area the size of New England is a very large order. It is obvious that the author had to make many compromises to produce a book that could at once be both "flora" and "manual". To me, it still seems a matter of wonder that the result of these concessions by Seymour is, nonetheless, a book of considerable merit. However, at this point I would urge that the authors of floras now in the making should adhere more strictly to the ideal concept of a flora, and that sponsors strive a bit harder to provide financial support. If the current trend is continued we may expect for the "Gray's Manual Range" that there will be an almost endless series of local, state and sectional "manuals" with greatly overlapping and repetitive information to the detriment of the peculiar information about ranges, locations, collectors and records that we have good reason to expect from a carefully documented "flora".

There is little point in describing the book's contents. By now it has been widely distributed and must indeed be familiar to many of the readers of Rhodora and should, of course, be in the hands of all those seriously interested in the flora of New England. Moreover, although I can't agree with all of Mr. Seymour's choices of scientific names or all his taxonomic decisions, these are often matters of opinion for which no competent author should be severely criticized.

It is, then, at certain of the floristic aspects of "The Flora of New England" that I will direct my attention, a few

points seeming to invite discussion and possible disagreement. On page XIII in the Introduction we encounter the following statement: "In determining what species constitute the flora of New England, all which give evidence of having grown in this region without cultivation within twenty-five years are included." My own feeling about this is quite at variance with that of Mr. Seymour; if there is good evidence that a species grew naturally in historic time in any part of New England it is still part of the flora, and if it is believed not to grow there now, it still should be listed and its present status indicated. For phytogeographical considerations certainly a flora would include such species. I don't know whether the occasional discrepancies between the ranges of certain species, in the listing of States for example, as given by Fernald in Gray's Manual and by Seymour, are attributable to the latter's interpretation of what constitutes a flora, but in working up ranges of New England species for phytogeographical projects I always resort to Gray's Manual as well as Seymour.

Mr. Seymour is certainly to be commended for the care that he has taken in personally examining specimens for his records, and for his avoidance of unsubstantiated reports. In many instances he has visited localities of botanical interest and thereby verified interesting records. One's confidence is heightened by the knowledge that he has made a number of interesting discoveries in the New England flora.

A great many of the published records of New England species appearing in Rhodora through the years and in other journals to a lesser extent, as well as in local floras and in special treatments of ferns, orchids, woody plants, etc., certainly have much to contribute to the "flora" of a region, even though in some instances the specimens cited or mentioned in these works may be lost or buried in some small herbarium. It is my recollection that Professor Fernald paid attention to all serious reports that came to his attention, though it must be admitted that he accepted these only when he had confidence in the author's critical capacity. In any

revision of "The New England Flora", I would hope that the author will thoroughly examine the voluminous body of literature dealing with the vascular flora of New England, sifting out of it pertinent data to make the record complete.

I know that Frank Seymour visited the herbarium of the University of New Hampshire sometime during the years while he was preparing his book, but our herbarium is growing fast and, had he checked it a year or two before the manuscript was published, he would have had a very large number of additional townships in New Hampshire and some new State records.

In the matter of citing localities where specimens have been seen, I have a few comments to make. Somewhat arbitrarily Seymour decided to list the township whenever a species has been collected only once in a particular county, but otherwise to list the county when two or more townships in that particular county are represented. However, there is no map showing the townships in each state, nor is there any listing of towns in their respective counties. Thus one needs a good atlas to plot the ranges of species. In order to provide information about ranges of all taxa effectively (which I would think might be a major consideration in a flora), it would be necessary either to supply range maps at least for critical taxa, or to provide many more township records and a ready means of locating townships. Thus the book would require considerable amplification of content to provide anything approaching exact data on distribution for a great many taxa. Moreover, many counties such as Coös County in New Hampshire and particularly several of the counties in Maine, are so large that any indication of presence by county is not enough.

The importance of a scientific work is determined by the role that it plays in the progressive development of the science. For my own work on the study of the plants of Northeastern America, this book will stand as a sound foundation. Its weaknesses will serve to show us a better way, and its

many strengths will provide the base on which those of us who are working on facets of the flora of New England can build.

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SPIRANTHES TUBEROSA. NEW FOR KANSAS — During a study of the family Orchidaceae in Kansas, it was discovered that several specimens of *Spiranthes tuberosa* Raf. had been collected in southeastern Kansas (Bourbon, Cherokee and Woodson Counties) and mistakenly identified as the more common *S. gracilis* (Bigel.) Beck. This orchid has previously been reported from Massachusetts, through the Atlantic States, south to south-central Florida, west to eastern Texas, Arkansas, Kentucky, Missouri and also Michigan. These specimens represent an extension northwestward of the range of the species.

REPRESENTATIVE SPECIMENS EXAMINED: Bourbon Co.: open wooded hillside, rocky clay soil, not common, 2 mi s of Uniontown, 2 October 1955, *McGregor* 11110 (KANU). Cherokee Co.: sandy rocky soil under *Quercus alba* and *Q. stellata*, not common, 5½ mi e of Baxter Springs, 3 October 1955, *McGregor* 11055 (KANU). Woodson Co.: open oak wooded bank, sandy soil, rare, Lake Fegan, Woodson Co. State Park, 25 September 1955, *Lathrop* 1884 (KANU).

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WHITE PHASE IN FLOWER DEVELOPMENT IN CYPRIPEDIUM ACAULE — Flowering plants of *Cypripedium acaule* were unusually abundant in the Williamsburg, Virginia, area in April and May of 1969: populations of hundreds of specimens were frequent.

On April 28th a friend showed me a young plant with a white lip. I had not noted this condition before, but subsequent search over the next few days revealed the lips of all young flowers in the area to be white and to become pink with maturity (Fig. 1).

Low temperatures for the period involved ranged from the mid-30's to the mid-40's. Could these unseasonably low temperatures account for the white phase in the development of these flowers? We shall attempt to get an answer another year by bringing young plants into temperature-controlled chambers.

Is there a likelihood that f. *albiflorum* of this species is temperature induced? It is at least provocative that in certain areas near the White Mountains the white form replaces the pink (Anderson, 1936) and that f. *albiflorum* has been reported in the mountains as far south as North Carolina (Correll, 1950).

We found pollen from ten plants in the white phase and from ten in the pink to be normal.

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Fig. 1. White and pink phases of *Cypripedium acaule*, April 29, 1969, Williamsburg, Virginia. Photo by Col. D. W. Noake, printed two thirds natural size and reduced in publication.

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THE TAXONOMY OF VERNONIA ACAULIS, V. GLAUCA AND V. NOVEBORACENSIS (COMPOSITAE)

Samuel B. Jones

Delimitation and identification of all taxonomic units are extremely difficult in the genus *Vernonia* since there are numerous, intermediate, perplexing forms (Ekman, 1914). One postulation is that the genus underwent rapid evolution in North America following the Cretaceous Period and that it is probably still evolving (Jones, 1964). This has resulted in the formation of population systems that appear somewhat morphologically disinct yet taxonomically difficult. Because the reproductive barriers among many of the species are incomplete (Jones, 1966, 1967), and because hybridization occurs commonly where species show biotic or adjacent sympatry, the genus is of interest from both evolutionary and taxonomic viewpoints.

The three species *Vernonia acaulis* (Walt.) Gleason, *V. glauca* (L.) Willd. and *V. noveboracensis* (L.) Michx. are the most eastern in the United States. They occur from Massachusetts to eastern Kentucky and Tennessee, and into Florida and Alabama along the Coastal Plain, Piedmont and mountains. The number of synonyms for the latter two species is an indication of the uncertainty which has characterized their treatment during the past 200 years. It is also obvious that the ranges of the three species have been poorly understood. The reason for this is that their

ranges were often copied from earlier floras which were erroneous. These taxa were chosen for systematic study because of the conspicuous variability within the taxa, especially in *V. noveboracensis*. The usual field and herbarium studies were supplemented by biosystematic investigations. In the course of this investigation, assistance has been received from many persons. It is not possible to thank them all specifically, but my sincere thanks are none the less real. This work was supported by National Science Foundation grant GB 7208 and the University of Georgia. Specimens for examination were obtained from the following herbaria: ALU; AUA; FSU; FLAS; GA; GH; NCU; NY; OS; PH; SMU; US; TENN; VDB; WIS; WVA. Annotated specimens of the three taxa may be found in all of these herbaria.

HISTORICAL ACCOUNT

Walter (1788) applied the name *Chrysocoma acaulis*, and he was clearly referring to a plant with a basal cluster of leaves. Michaux (1803) described the same taxon and gave it the name *Vernonia oligophylla*. In 1891 Kuntze applied the generic name of *Cacalia*. In 1906 Gleason recognized the name of Walter and made the combination *Vernonia acaulis* (Walt.) Gleason. *Vernonia georgiana* Bartlett has been shown to be a hybrid between *V. acaulis* and *V. angustifolia* Michx. (Jones, 1967).

It is obvious from an examination of the microfiche of the Linnaean Herbarium that Linnaeus' (1753) *Serratula noveboracensis* refers to *Vernonia noveboracensis*. Apparently his *Serratula praealta* differed from the type only in the shorter appendages of the involucral bracts (Gleason, 1906). Walter's (1788) *Chrysocoma tomentosa* shows no essential difference from *V. noveboracensis*. Michaux (1803) transferred the species to the genus *Vernonia* making the combination *V. noveboracensis* (L.) Michx. He also recognized *V. praealta*. Hill (1768) applied the generic name *Behen*, and Miller in 1768 used the name *Serratula caroliniana* Mill. Walter's (1788) *Chrysocoma tomentosa* was recognized by Elliott (1824); however, Elliott was not certain that his

plant was the same as that described by Walter. More recently, Steele (1901) discussed the matter, and regarded the name *V. tomentosa* Ell. to be a plant of wet places from the south Atlantic Coast. Gleason (1906) studied Steele's specimens and felt that they did not warrant its separation as a distinct species. According to Gray (1852), *V. rugeliana* Shuttlew. is the ordinary form of *V. noveboracensis*. The next major addition to the synonomy was that of *V. harperi* Gleason (1906). It is based on *Harper* 1424 from Coffee County, Georgia. Gleason distinguished it from *V. noveboracensis* because of its larger heads and more numerous flowers.

Serratula glauca L. was based on a plant collected by Clayton, studied by Linnaeus and fragments were given to Asa Gray in 1839 (Fernald, 1941). Willdenow (1804) made the combination *Vernonia glauca* (L.) Willd. Gray (1884) included *V. glauca* as part of *V. noveboracensis* var. *latifolia*. Britton's (1898) description of *V. noveboracensis tomentosa* (Walt.) Britton refers to *V. glauca*. In 1941 Fernald described *V. glauca* (L.) Willd. forma *longiaristata* Fernald which has longer bract tips.

SYSTEMATIC TREATMENT

Key to Species

1. Principal leaves basal, the stem leaves usually much reduced ..... 1. *V. acaulis*
1. Principal leaves cauline, the stem leaves usually not reduced except near inflorescence 2
   2. Pappus straw-colored to white, lower surface of leaves paler than upper; leaves usually rather abruptly narrowed at base; plants of well drained soil; normally flowering in July ..... 2. *V. glauca*
   2. Pappus purple or brownish-purple, lower surface of leaves not much paler than upper; leaves gradually narrowed at base; plants of moist soil; normally flowering in August and September ..... 3. *V. noveboracensis*

1. *Verononia acaulis* (Walt.) Gleason, Bull. N.Y. Bot. Gard. 4: 222. 1906.
   Chrysocoma acaulis Walt., Fl. Car. 196. 1788.
   Type: Not examined. Photograph of type in PH.

Vernonia oligophylla Michx., Fl. Bor.-Am. 2: 94. 1803.
Cacalia acaulis Kuntze, Rev. Gen. 968. 1891.

Stems erect, glabrous to thinly puberulent, simple to the inflorescence, 3-10 dm high. Leaves mostly basal, basal leaves 20 (12-30) cm long, 7 (4-10) cm wide, oblong to obovate, sparsely pubescent above, sparsely pubescent to nearly glabrous below, tip acute, base attenuate, margins coarsely and irrgularly serrate, cauline leaves bractlike. Inflorescence loose and open branched. Heads 42 (31-59) flowered. Involucre broadly campanulate, 6.6 (5.0-8.5) mm high, 7.0 (5.7-8.5) mm wide. Bracts lanceolate to linear elliptic. Bract tips acuminate to long acuminate. Bracts greenish-purple, thinly puberulent on back. Achenes sparsely pubescent, strongly ribbed, resinous, 3 (2.7-3.2) mm long. Pappus straw colored to white, bristles 5.5-9.0 mm long, scales narrow, 0.5-1.0 mm long. Flowering in July. Chromosome number $n = 17$. Habitat: uplands, sandy woods, flat-

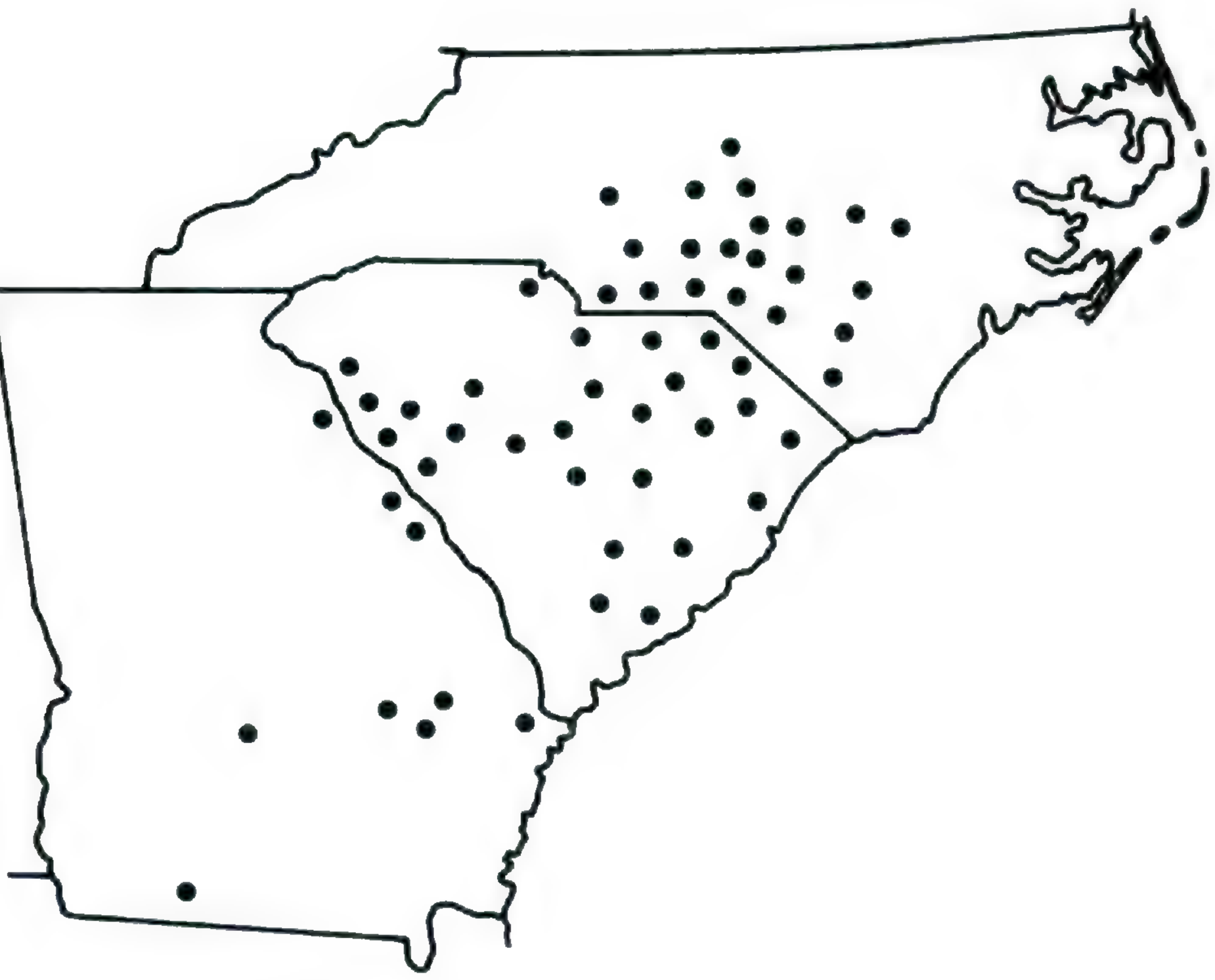

Figure 1. Distribution map of *Vernonia acaulis* based on county distributions.

woods and sandhill ecotones. Distribution: in part of Coastal Plain and Piedmont of North Carolina, South Carolina, Georgia (see Fig. 1).

Vernonia acaulis is quite distinct and is easily identified. Occasionally, it does hybridize with *V. noveboracensis* and *V. angustifolia* Michx. The F_1 hybrids are easy to recognize as they are intermediate between their parents. This hybridization does not seem to have blurred the species lines. Local population samples were made in Elbert Co., Ga. (15736) and Montgomery Co., N. C. (15783). Transplants were grown in the garden and the greenhouse from these two locations. Table 1 presents the sample means, standard deviations, coefficients of variation and ranges of certain morphological characters from the North Carolina population. There is probably no more variation between local populations than one would normally expect in outbreeding population systems. Experimental hybrids were made among *V. acaulis*, *V. noveboracensis*, *V. glauca* and *V. angustifolia*. The F_1 hybrids were intermediate. They had good pollen stainability with aniline blue in lactophenol and good pairing of the chromosomes at meiosis.

TABLE 1

Vernonia acaulis: population sample means ($\bar{x}$), standard deviations (s), coefficients of variation (C) and ranges of seven morphological characters; n = 25; population sample 15783, Montgomery Co., N. C.

Character	$\bar{x}$	s	C	Range
lower leaf width cm	6.5	1.4	0.2	3.7 - 10.0
lower leaf length cm	20.2	4.0	0.2	12 - 30
middle leaf width cm	0.7	0.4	0.6	0.2 - 2.0
middle leaf length cm	8.7	3.9	0.4	1.7 - 15.6
involucre width mm	7.0	0.7	0.1	5.7 - 8.5
involucre length mm	6.6	0.9	0.1	5.0 - 8.5
flowers per head	41.8	7.0	0.2	31 - 59

Normally, *Vernonia acaulis* is ecologically isolated from *V. angustifolia*. The latter usually grows in drier places than the former. It is also ecologically as well as seasonally isolated from *V. noveboracensis*. *Vernonia acaulis* flowers in July, while *V. noveboracensis* flowers in August. The habitat in which *V. noveboracensis* grows is often quite wet, while *V. acaulis* grows in well-drained soil. Isolation, however, is not always completely effective as the flowering periods may overlap or the ecological niches may be within a few meters of each other.

2. *Vernonia glauca* (L.) Willd., Sp. Pl. 3: 1633. 1804.
Serratula glauca L., Sp. Pl. 818. 1753.
Type: According to Fernald (1941), it is based on a specimen collected by Clayton, studied by Linnaeus and fragments given to Gray in 1839. Not examined.
Suprago glauca Gaertn., Fruct. 2: 402. 1791.
Vernonia noveboracensis latifolia A. Gray, Syn. Fl. N. Am. 1: 89, in part. 1884.
Vernonia noveboracensis tomentosa Britton, Britt. & Brown. Ill. Fl. 3: 302, in part. 1884.
Vernonia glauca (L.) Willd. forma *longiaristata* Fern., Rhodora 43: 652. 1941.

Stems erect, glabrous, simple, 10-16 dm high. Leaves numerous, 15 (12.5-19) cm long, 5 (3.4-7.4) cm wide, ovate-lanceolate to almost ovate, glabrous or scabrellate above, pale and thinly puberulent below, tips short-acuminate, abruptly narrowed at the base, margins irregularly dentate to nearly entire. Inflorescence compact. Heads 40 (32-48) flowered. Involucre broadly campanulate 7.3 (5.0-8.8) mm high, 7.4 (6.1-8.5) mm wide. Bracts, inner lance-ovate, outer lanceolate, bract tips acute or acuminate to long acuminate. Bracts greenish-purple, glabrous or puberulent. Achenes nearly glabrous, ribbed, 3 (2.7-3.3) mm long. Pappus straw-colored to white, bristles 6.7 mm long, scales narrow 0.4-0.8 mm long. Flowering in July. Chromosome number, $n = 17$. Habitat: edge of well-drained upland oak-hickory woods. Distribution: mountains and piedmont from Pennsylvania to Alabama (see Fig. 2).

Figure 2. Distribution map of *Vernonia glauca* based on county distributions.

Local population samples were collected in Clarke Co., Ga. (15146) and in Orange Co., N. C. (15788). Transplants were grown in the greenhouse and garden from the above locations and also from Gwinnett Co., Ga. (15349). Experimental hybrids were produced with a number of other species of *Vernonia*, including *V. noveboracensis* and *V. acaulis*. The F_1 hybrids had good chromosome pairing at meiosis, and the pollen stained well with aniline blue in lactophenol.

Although misinterpretation of *Vernonia glauca* versus *V.*

noveboracensis is common, *V. glauca* is morphologically and ecologically distinct from the latter. There is some variation within and between the populations; however, this variation is probably no more than is normally expected in heterozygous individuals and populations. This normal variation includes Fernald's (1941) forma *longiaristata*, and it is certainly not worthy of a name. Table 2 presents some morphological measurements from one sample.

TABLE 2

Vernonia glauca: population sample means ($\bar{x}$), standard deviations (s), coefficients of variation (C) and ranges of six morphological characters; n = 25; population sample 15146 Clarke Co., Ga.

Character	$\bar{x}$	s	C	Range
middle leaf width cm	4.9	1.0	0.2	3.4 - 7.4
middle leaf length cm	15.7	1.7	0.1	12.5 - 19.0
involucre width mm	7.4	0.6	0.1	6.1 - 8.5
involucre length mm	7.3	0.9	0.1	5.0 - 8.8
flowers per head	40.5	4.4	0.1	32 - 48
ratio middle leaf length/width	3.3	0.6	0.2	2.4 - 5.0

Natural hybrids between *Vernonia glauca* and *V. flaccidifolia* Small were collected in Gwinnett Co., Ga. (15349). The parents and the hybrids were at the edge of oak-hickory woods and in flower at the same time. During the course of this study no specimens of natural hybrids between *V. glauca* and *V. noveboracensis* were unequivocally designated. They should, however, be looked for. These two species are normally seasonally and ecologically isolated. *Vernonia glauca* flowers in July, while *V. noveboracensis* blooms in August. In addition, the former grows in well-drained upland woods and is rarely found in the lowlands, while the latter is found in wet meadows, low roadsides, and stream banks and found often in standing water. Experimental F_1 hybrids are intermediate between their parents in the key characters of pappus color and leaf shape.

Figure 3. Distribution map of *Vernonia noveboracensis* based on county distributions.

3. *Vernonia noveboracensis* (L.) Michx. Fl. Bor.-Am. 2: 95. 1803.

Serratula noveboracensis L., Sp. Pl. 818. 1753.

Type: Not examined, photograph of type in microfiche of Linnaean Herbarium. Photograph of type in GH.

Serratula praealta L., Sp. Pl. 818. 1753.

Behen noveboracensis Hill, Hort. Kew. 68. 1768.
Behen praealtum Hill, Hort. Kew. 68. 1768.
Serratula caroliniana Mill., Gard. Dict. ed. 8. Serratula no. 7, 1768.
Chrysocoma tomentosa Walt., Fl. Car. 196. 1788.
Vernonia praealta Michx., Fl. Bor.-Am. 2: 95. 1803.
Vernonia tomentosa Ell., Bot. S. C. & Ga. 2: 288. 1821.
Vernonia noveboracensis (L.) Michx. var. *praealta* Wood, Classbook 183. 1845.
Vernonia rugeliana Shuttlew.; A. Gray, Pl. Wright. 1: 82. 1852.
Vernonia noveboracensis (L.) Michx. var. *latifolia* A. Gray, Sym. Fl. N. Am. 2: 89. 1884.
Cacalia noveboracensis Kuntze, Rev. Gen. 324. 1891.
Vernonia noveboracensis tomentosa Britton, Porter & Britton, Mem. Torrey Bot. Club 5: 311. 1894.
Vernonia harperi Gleason, Bull. N. Y. Bot. Gard. 4: 221. 1906.

Stems erect, glabrous to thinly pubescent, simple to the inflorescence 10-25 dm high. Leaves numerous, 18 (12-28) cm long, 3.4 (1.3-5.5) cm wide, lanceolate, glabrous or scabrellate above, thinly tomentose below, tip acuminate, base attenuate, margins nearly entire. Inflorescence loose and spreading. Heads 44 (30-65) flowered. Involucre campanulate, 12 (7-17) mm high, 7.7 (6-10) mm wide. Bracts triangular-ovate. Bract tips acuminate to long acuminate with a filiform appendage. Bracts greenish-purple, pubescent and sometimes ciliate. Achenes sparsely pubescent, ribbed, 4.1 (4-4.5) mm long. Pappus brownish-purple, bristles 6.5 (6-7) mm long, scales linear, 0.4-0.8 mm long. Corollas whitish and pappus pale in forma *albiflora* Britton, 1890, Bull. Torrey Bot. Club 17: 124. Corollas lilac in forma *lilacina* Oswald, 1957, Phytologia 5: 465. Flowering in August and September. Chromosome number, $n = 17$.
Habitat: low, wet roadsides, wet meadows, creek banks.
Distribution: piedmont, coastal plain and mountains from Massachusetts to eastern Kentucky and eastern Tennessee into Alabama and Florida (see Fig. 3).

Of the three taxa, *Vernonia noveboracensis* is by far the most variable, and it has the greatest geographical range. In Gleason's (1906) revision of *Vernonia*, the species group *Noveboracenses* included two species *V. noveboracensis* (L.) Willd. and *V. harperi* Gleason. The former has a wide distribution from Alabama to Massachusetts on the Atlantic Coastal Plain, Piedmont Plateau, and the mountains. According to Gleason (1923), it gave rise to *V. harperi* of the Atlantic Coastal Plain in south Georgia; this species has larger heads with more flowers. As Ekman (1914) noted, however, Gleason's species are very small, narrowly defined and, as a rule, based upon very meager material.

The purpose of this phase of the study was to investigate the biological complexity of *Vernonia noveboracensis* and *V. harperi* in order to help clarify their systematics. In this study observations and conclusions were based on field work, on analysis of local population samples, on garden studies, on laboratory work, and on examination of herbarium specimens.

Population samples: Local population samples (mass collections) of 25 individuals each were made from four localities in Georgia in late August and September of 1967. These provided a transect from the mountains to the Coastal Plain. Population sample 15048 was collected in a wet pasture in White County in the Blue Ridge Mountains and is designated as BR. Population sample 15117 was made from a colony growing on a low moist roadside in Greene County in the Piedmont Plateau and is called PP. A wet pasture in McDuffie County near the Fall Line provided 15144, and it is labeled FL. Population sample 15086 was collected from a wet power line right-of-way in Tattnal County, just a few miles from the type location of *V. harperi*. Tattnal County is in the Atlantic Coastal Plain, and this sample is designated as AC. Characters in which *V. harperi* and *V. noveboracensis* differ, as well as characters in which they are similar, were used in scoring the specimens. Ten characters were measured or scored on each individual from the samples. The numerical values thus ob-

tained were then punched on IBM cards. The characters were as follows: (1) width of the middle stem leaves (cm); (2) length of the middle stem leaves (cm); (3) pubescence of the middle stem leaves (for scoring purposes, categories were set up from 1 = glabrous to 6 = pubescent with hairs over .25 mm long and crowded); (4) dots on lower leaf surface range from 1 = not dotted to 3 = strongly dotted; (5) bract tip shape (9 categories were established for scoring purposes; however, these populations were all scored either 8 or 9); (6) pappus color, range from 1-5, with 1 = off-white to 5 = brown with a purple tinge; (7) involucre width (mm); (8) involucre length (mm); (9) number of flowers per head; (10) leaf length/width ratio.

The population samples were compared using the computer program BMDO7M, Stepwise Discriminant Analysis, version of 1 Sept. 1965, Health Sciences Computing Facility, UCLA. The program is a type of multi-variant analysis using a stepwise fitting in which the sums of squares and products are re-arranged at each stage of the fitting so that the variable giving the largest reduction of the residuals is the next one fitted. The standard deviations and means were obtained from the print-out of this program. From these the coefficients of the variation were determined. The variable characters within and between the populations were compared using scatter diagrams and polygons.

The type specimen of *Vernonia harperi* was similar to

TABLE 3

Number of cases of *Vernonia noveboracensis* classified into group by BMDO7M, Stepwise Discriminant Analysis Program.

Population[1]	BR	PP	FL	AC
BR	15	6	4	0
PP	0	25	0	0
FL	2	0	22	1
AC	0	0	0	25

[1]Blue Ridge (BR); Piedmont Plateau (PP); Fall Line (FL); Atlantic Coastal Plain (AC).

certain of the AC plants. Analysis of herbarium specimens indicated that there is variation in *V. noveboracensis*; however, the changes in characters are either gradual over long distances or not correlated geographically or morphologically with other characters. The results from the computer transect analysis indicated that all populations were somewhat distinct (see Table 3). However, PP and AC individuals would not have been misclassified into the other three populations. On the other hand, some BR plants would have been classified into PP and FL. Likewise, FL had some plants which fell into BR and AC.

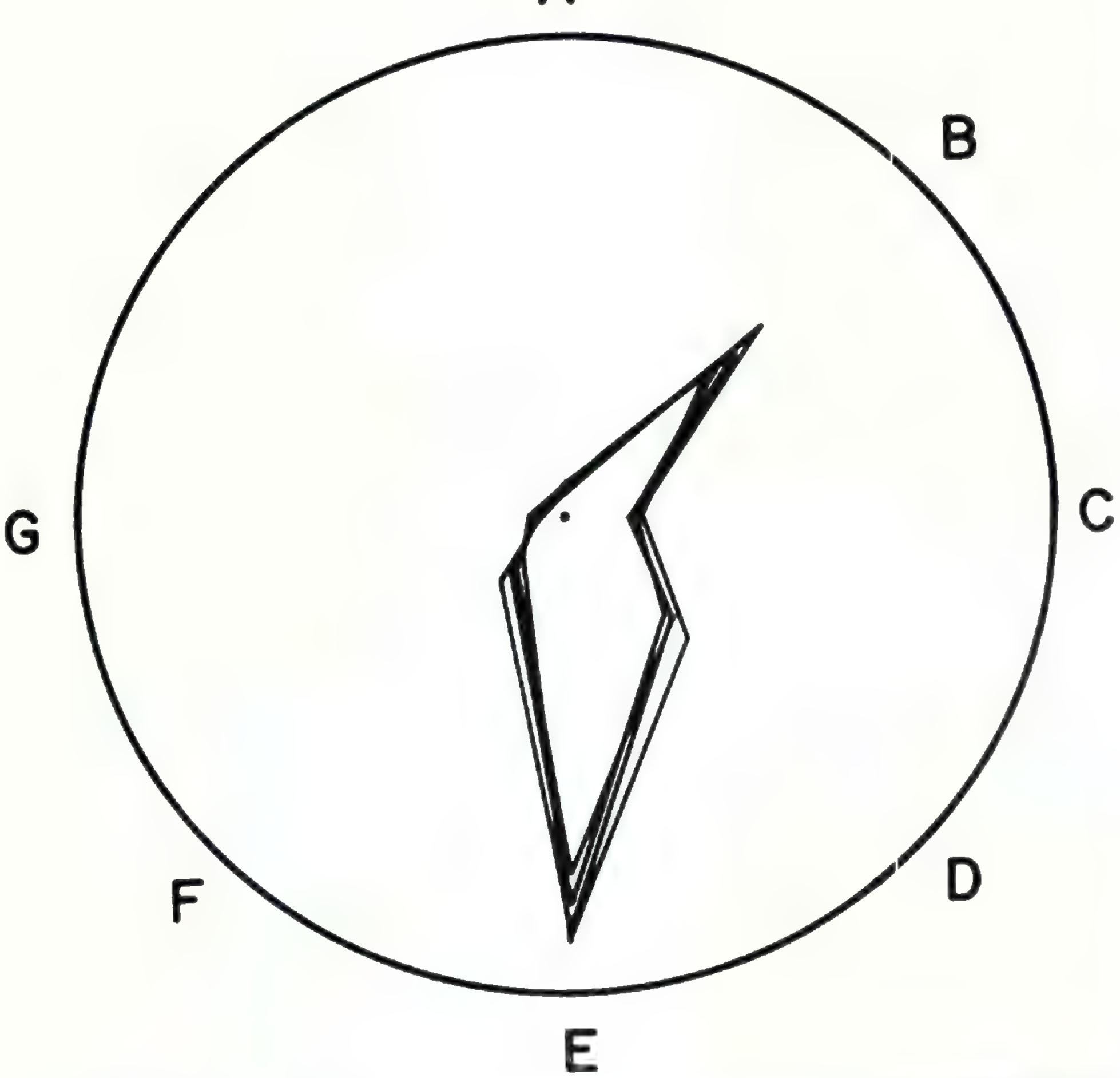

Figure 4. Polygons based on the sample means of the four populations (BR, PP, FL, AC) of *Vernonia noveboracensis*. A, leaf width; B, leaf length; C, involucre width; D, involucre length; E, number of flowers per head; F, ratio of leaf length/width; G, pubescence score.

On the basis of the multi-variant analysis, the value of the characters presented in Table 4, the coincidence of the polygons (Fig. 4) and the scatter diagram (Fig. 5), some differentiation is indicated, yet the populations are probably indistinguishable. Grant (1963) has indicated that most outbreeding populations are variable or polymorphic. He noted that this is due to the diversity in the allelic forms of one or more genes. Since allelic forms do exist, no single

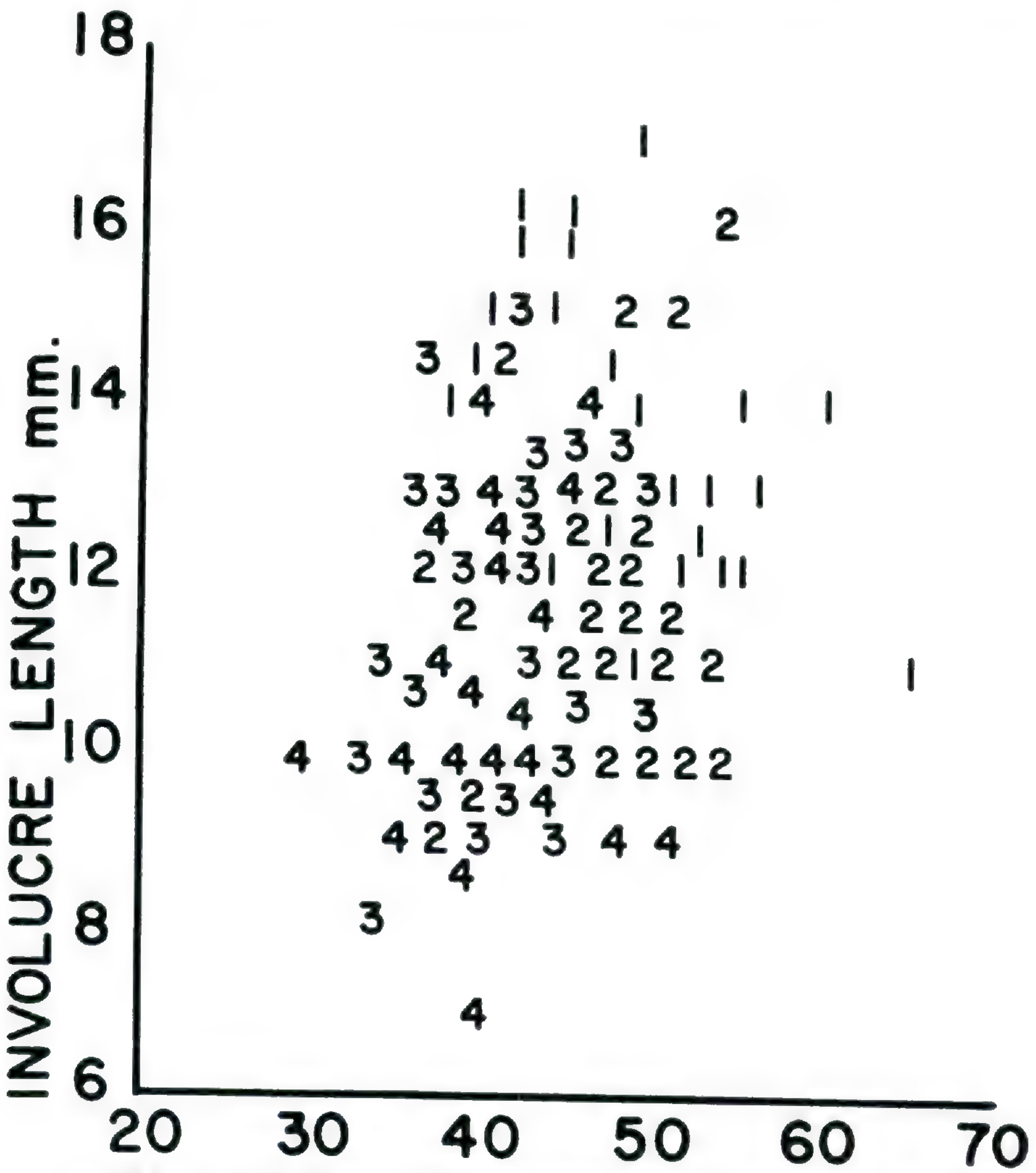

Figure 5. Scatter diagram of individuals of the four populations (AC, 1; FL, 2; PP, 3; BR, 4) of *Vernonia noveboracensis*.

individual will carry all the genetic variation found within the populations. The breeding population maintains and stores this genetic variation which is conserved by the reproductive process. Changes in the allelic frequencies could be caused by mutation, gene flow, natural selection and genetic drift.

Chromatographic patterns: The chromatographic patterns of the phenolic compounds of eight individuals from each population sample (BR, PP, FL and AC) were investigated through the use of 2-dimensional paper chromatography. Dried flower heads were extracted in 1% HCl in methanol for 30 hours, and the extracts were concentrated by evaporation. About 1 ml of the extract was applied in one spot to Whatman 3 MM chromatographic paper and then developed by the descending method. Development employed the following solvents in the order listed: (1) tertiary butanol:acetic acid:water (3:1:1 v/v for 24 hours), and (2) acetic acid:water (15:85 v/v for four hours). Upon drying the chromatograms were examined in daylight, in transmitted longwave ultra-violet light (UV) both with and without the presence of ammonia vapor, and by reflected UV light after having been sprayed with Benedict's solution. Each plant was chromatographed twice.

Twenty-two compounds were followed in the course of this study. No attempt was made to identify the compounds; however, color reactions with several reagents indicated that most were probably phenolic compounds. Although some compounds were either absent or below the threshold of detection in certain of the plants from each population, no pattern was found that would serve to differentiate the populations.

Hybridization and garden experiments: Crosses were made in all possible combinations between BR, PP, FL, AC and between *Vernonia acaulis* and *V. glauca*. The F_1 hybrids were grown to maturity and pairing of the chromosomes was observed at meiosis. Pollen grains were stained in aniline blue in lactophenol for 24 hours. Transplants from several locations were observed in the garden and green-

TABLE 4

Vernonia noveboracensis: population sample means ($\bar{x}$), standard deviations (s), ranges, and coefficients of variation (C) of seven morphological characters that were variable within and between the populations.

Population[1]	$\bar{x}$	s	C	Range
Middle leaf width cm				
BR	3.8	0.8	0.2	2.4 - 5.5
PP	3.3	0.6	0.2	2.5 - 4.5
FL	2.5	0.7	0.3	1.3 - 4.3
AC	3.8	1.0	0.3	2.6 - 5.5
Middle leaf length cm				
BR	19.1	3.7	0.2	12.1 - 24.8
PP	21.8	3.8	0.2	14.5 - 28.0
FL	17.1	2.8	0.2	12.9 - 24.5
AC	16.5	2.6	0.2	12.4 - 21.0
Involucre width mm				
BR	7.0	0.7	0.1	6.0 - 8.5
PP	7.7	0.8	0.1	6.5 - 9.0
FL	7.3	0.8	0.1	6.0 - 9.2
AC	8.7	0.8	0.1	7.5 - 10.0
Involucre length mm				
BR	11.7	1.9	0.2	8.0 - 15.0
PP	10.7	1.8	0.2	7.0 - 14.0
FL	11.7	1.9	0.2	9.0 - 16.0
AC	13.8	1.8	0.1	11.0 - 17.0
Number of flowers per head				
BR	40.6	4.4	0.1	33 - 48
PP	40.4	4.4	0.1	30 - 49
FL	46.2	4.5	0.1	38 - 54
AC	48.9	6.6	0.1	39 - 65
Ratio leaf length/width				
BR	5.1	1.3	0.3	3.0 - 9.3
PP	6.6	1.1	0.2	3.7 - 8.8
FL	7.0	1.5	0.2	3.4 - 9.9
AC	4.6	1.2	0.3	2.6 - 7.3

Pubescence score				
BR	2.6	0.8	0.3	1 - 4
PP	2.8	0.4	0.2	2 - 3
FL	3.0	0.5	0.2	2 - 4
AC	3.3	0.6	0.2	2 - 4

[1]Blue Ridge (BR); Piedmont Plateau (PP); Fall Line (FL); Atlantic Coastal Plain (AC).

house for over two years. The F_1 hybrids were vigorous and had good chromosome pairing at meiosis. Pollen stainability was usually above 90%. All populations studied have a chromosome number of $n = 17$. The morphological variations seemed to be maintained in the transplant garden. Certain F_2 hybrids from the cross *V. noveboracensis* × *V. glauca* had reduced pollen stainability and poor chromosome pairing at meiosis. This indicates that hybrid breakdown may occur in later generations even though the F_1's are fertile.

Vernonia noveboracensis hybridizes with *V. altissima* Nutt. in eastern Tennessee, in eastern Kentucky and in Pennsylvania. This produces some specimens with smaller heads. In North Carolina *V. noveboracensis* hybridizes with *V. acaulis*. Also in that state, it may occasionally hybridize with *V. angustifolia* Michx. Herbarium specimens were observed that might possibly have been natural hybrids between *V. noveboracensis* and *V. glauca*. All of these hybrid combinations have been produced in the greenhouse. *Vernonia noveboracensis* is usually seasonally and ecologically isolated from *V. acaulis* and *V. glauca* where they are sympatric. The former blooms in August and September, while the latter two species flower in July. Also *V. noveboracensis* grows in much wetter soil than the other two. From an evolutionary viewpoint, the most important natural hybridization is that with *V. altissima* as some local introgression seems to have occurred.

POSSIBLE EVOLUTIONARY RELATIONSHIPS

The presence of relatively few morphological and physiological differences is evidence of close relationships among

these three taxa. Gleason (1923) suggests that they may have been derived from the more primitive *Vernonia angustifolia* or, more likely, a common ancestor of all of our present day eastern species. Present evidence indicates that this was a logical assumption. The taxa considered here apparently diverged from a common ancestor during past geological history.

The species considered in this paper have several features in common, including around 40 flowers per head. In addition, they all have acuminate bract tips, although the tips of *Vernonia noveboracensis* are often filiform and longer. The pappus of both *V. glauca* and *V. acaulis* is straw-colored to white, whereas it is brown to purple in *V. noveboracensis*. The latter flowers in August while the other two species bloom in July. These characteristics are normally key characters in the species of *Vernonia* of eastern North America.

The basal leaves of *Vernonia acaulis* seem to function in reducing the competition from the sparse surrounding vegetation of its habitat. The cauline leaves and longer stems of the other two taxa seem to be of selective advantage in overcoming their competition, for they are generally taller than the plants around them. This is especially true with *V. noveboracensis* which grows in moist areas with vigorous competing vegetation. All three species begin to grow early in the spring.

Vernonia acaulis grows in uplands, sandy woods, well-drained flatwoods, and sandhill ecotones. Low, wet roadsides, wet meadows, and creek banks provide habitats for *V. noveboracensis*, whereas *V. glauca* is always found in well-drained, upland, oak-hickory woods.

Geographical isolation of segments of the ancestral population system, in conjunction with natural selection in response to influences of past changes in the earth's surface, climate and vegetation, could have produced the physiological and morphological differentiation of these species. Presently, the population systems appear to be separated

by prezygotic seasonal and ecological isolating mechanisms and by a postzygotic hybrid breakdown in F_2 generations.

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DISTRIBUTIONAL HISTORY OF EPILOBIUM HIRSUTUM (GREAT HAIRY WILLOW-HERB) IN NORTH AMERICA[1]

RONALD L. STUCKEY

The introduction, establishment, and spread of non-indigenous aquatic and marsh plants in eastern North America have continually been increasing since the coming of European man. Documented cases have been published for *Butomus umbellatus* (Core, 1941; Stuckey, 1968b), *Hydrocharis morsus-ranae* (Dore, 1968), *Lycopus asper* (Stuckey, 1969), *Najas minor* (Meriläinen, 1968), and *Rorippa sylvestris* (Stuckey, 1966). Attempting to determine the distributional history of these non-indigenous (introduced) species presents to present-day botanists new challenges and questions, such as: When did the species first become introduced? How far and to what parts of the country have the plants spread? Into what habitats do the plants become established? What are the various probable pathways and rates of migration that the plants have taken? What habitats and geographical areas can be predicted for the plants' invasion and establishment in the future? These are basic questions that must be considered in understanding the biology and distribution of the species. It is important to put on record the time and location of the occurrences of plants that come into new areas because it gives botanists knowledge about when and to where the plants are moving, and therefore provides documentation for the changes that are continually occurring in the flora. Furthermore, the invasion of aquatic and marsh plants becomes critical for

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[1]Contribution from the Botany Program (Paper No. 766), the Herbarium, and The Franz Theodore Stone Laboratory, The Ohio State University, Columbus 43210.

Fig. 1. *Epilobium hirsutum* (Great hairy willow-herb) from along the banks at edge of an artificial pond at The Maples, No th Central Branch of the Ohio Agricultural Research and Development Center, SE side of Sandusky Bay, NW corner of Erie County, Ohio, ca. 4 mi. NW of Castalia, 10 Aug 1968, *Stuckey* 7327, OS. Photograph by R. L. Stuckey.

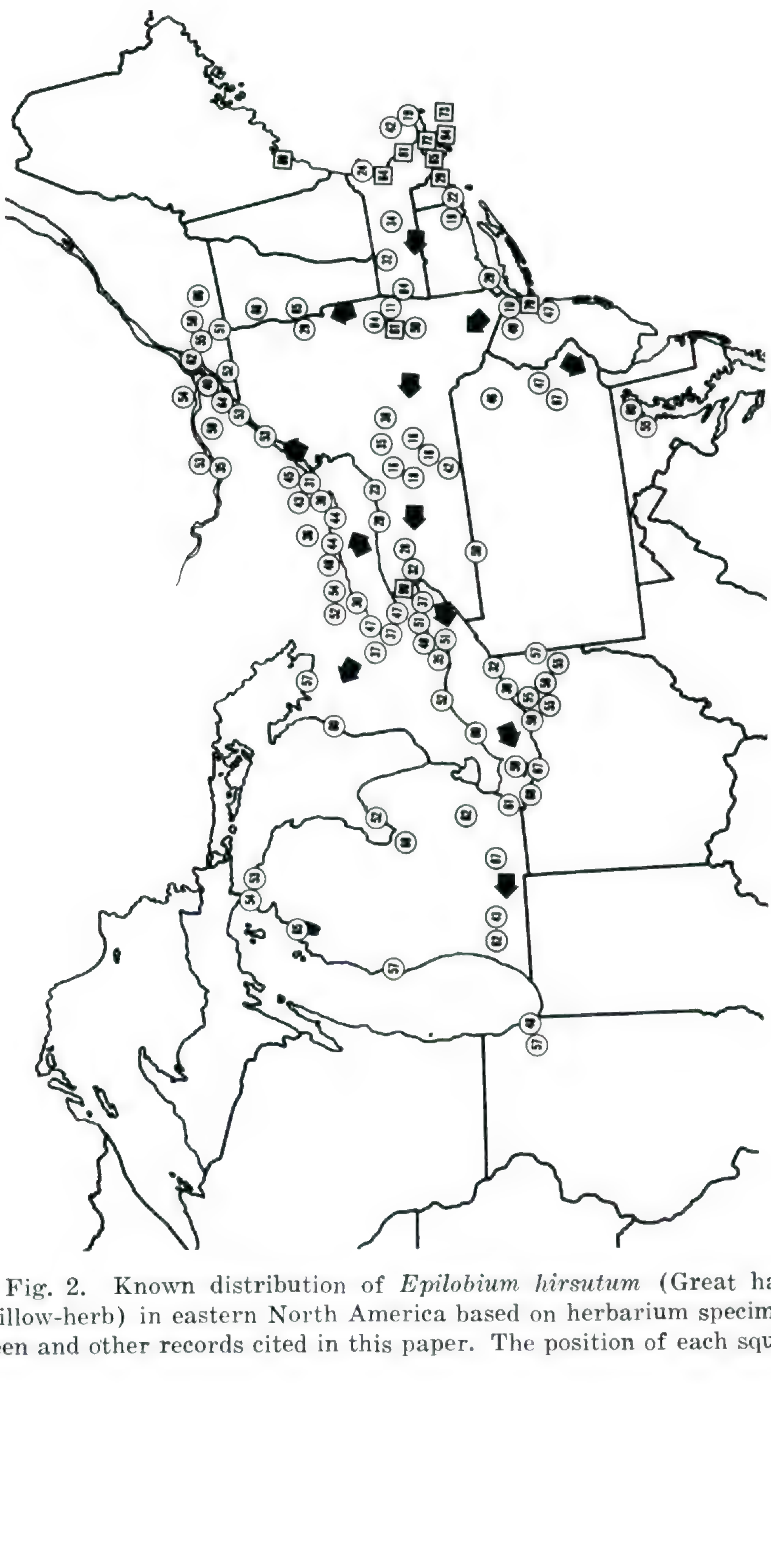

Fig. 2. Known distribution of *Epilobium hirsutum* (Great hairy willow-herb) in eastern North America based on herbarium specimens seen and other records cited in this paper. The position of each square

those interested in wildlife management. The invasion and establishment of plants new to a marsh can considerably alter the habitat and have effects on the future composition of the flora, the food chain of the animals, and perhaps ultimately determine the succession and total fate of the ecology of the marsh.

This member of the evening-primrose family (Onagraceae), *Epilobium hirsutum* L. (fig. 1) is a tall (up to 2 meters) plant with sessile, somewhat clasping, soft and hairy leaves. The flowers have reddish-purple, obcordate petals and are arranged in racemes in the axils of the leaves on the upper part of the plant. Reproduction is by short rootstalks or subterranean stolons and by seeds dispersed with the wind. When growing in water or water-saturated mud those parts of the plant in contact with the water develop arenchyma tissue (Batten, 1918).

Great hairy willow-herb is a species of the marshes of Eurasia that has become established within the past 140 years in eastern North America. Here it occurs in a wide range of habitats. The earliest North American records indicate that the species grew in cultivated grounds, as a weed in gardens, or on ballast. As the species became established along the northeastern coast of the United States and then spread inland, it has come to occupy river, creek, and stream banks, roadside and drainage ditches, canals, edges of ponds and lakes, wet meadows and pastures, railroad tracks and ditches, extensive marshes, and edges of swamps.

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or circle represents a locality where a plant has been collected. Numbers in the squares are the last two digits for the year in which the plant was collected if before 1900, and the numbers in circles are the last two digits for the year of collection if since 1900. The oldest known collection is mapped for each locality. The arrows indicate the possible migration pattern that the species has taken through time as the plants have moved from the east coast to inland in the Great Lakes region and elsewhere. Since the preparation of this map, additional specimens have become available for locations along the southeast shore of Lake Erie in New York, between Ripley and Westfield, Chattauga County (*Beth Evans* s.n., OS, Sep 1969) and in Pennsylvania, southeast of the city of Erie, Erie County (*Beth Evans* s.n., OS, Sep 1969).

Epilobium hirsutum can be common in low wet places, especially where fires have burned the land (McKeever, 1961). According to several of the more recent floristic manuals of the region (Fernald, 1950; Gleason, 1952; Gleason and Cronquist, 1963) and a recent taxonomic revision of the genus for North America (Munz, 1965), *E. hirsutum* occurs in southern Quebec, southern Ontario, New England, south to New Jersey, Pennsylvania and westward through New York, Ohio, Michigan, and Illinois. Munz also reports it from Washington. Figure 2 shows the present known distribution in eastern North America.

INTRODUCTION AND EARLY SPREAD

The earliest known record of *Epilobium hirsutum* from North America is based on a collection from Newport, Rhode Island, July 1829 (*Bridges s.n.* PH), but no habitat or other information about its environment or history is given with the specimen. *E. hirsutum* was not recorded in the fourth edition (or earlier editions) of Gray's *Manual* (Gray, 1863), but it was reported in the fifth edition (Gray, 1867) as "Spontaneous in waste grounds, New Bedford, Mass. [without date] *(T. A. Greene)* and Roxbury [towards Dorchester, 1864] *(D. Murray)*; and in a ravine near [1 mi n of] Albany, New York [1861] *(C. H. Peck)*."[2] According to *A Catalogue of the Plants . . . of Nantucket, Mass.* (Owen, 1888), *E. hirsutum* was "Raised in or about 1855 in a garden on Union St., from which it gradually spread by seed," until by 1888 it was "well established in many waste places about town and . . . sometimes in the fields." In a flora of Essex County, Massachusetts, Robinson (1880) noted that the plants grew in "old gardens and waste heaps in Salem about 1860, and still continues in some places." Other early occurrences for eastern Massachusetts based on herbarium specimens seen are from New Bedford, 1865 (*Robbins s.n.*, NEBC), Woods Hole, 1872 (*Palmer s.n.*, US), Nantucket, 1873 (*Harrington s.n.*, MICH), Plymouth, 1881 (*Clark* 898, NEBC), and Dartmouth, 1888 (*Sturtevant* 5037,

[2]Data given in brackets are taken from the original specimens at GH.

NY). In the mid-nineteenth century the species must have become established in the Newport, Rhode Island, area, because Tweedy (1881) reported it as "not uncommon in waste ground surrounding dwellings." In Maine, the earliest known specimen was collected in 1889 at Portland and bears the notation, "weed in garden," (*Fernald s.n.*, GH, NEBC).

In New York, *E. hirsutum* is not mentioned by Torrey (1843), and except for the Albany locality given by Gray (1867), the next report for the state of New York appears to be Dudley (1886), who wrote that the plant was found in 1874 near the mill west of Cascade Place in the Cayuga Basin in the central part of New York state. A voucher specimen for this record has not been seen. Brcwn (1878) mentioned the willow-herb as "scarce" on ballast and on made land in the New York City area. In the following year he collected a plant on ballast ground at Gowanus, Brooklyn (*Brown s.n.*, US). The species apparently became introduced farther into the interior in the Buffalo area about 1882, based on information by Day (1882-1886, 1883a, 1883b) who said that seeds of certain plants, new to the Buffalo area, were sown in waste places in the city and suburbs during 1882. According to Day (1888), *E. hirsutum* was introduced, but perhaps not established, near Clifton, Ontario, which is north of Buffalo. Voucher specimens of the willow-herb from the city of Buffalo or town of Clifton have not been seen, but specimens are known from the area about Niagara Falls. The earliest known specimen seen is from Queen Victoria Park, Niagara Falls, July 1890 (*Schafer s.n.*, PH). A specimen obtained in 1894 by R. Cameron (CAN) has the note "naturalized at Niagara Falls, introduced in garden seed." Before the turn of the century Gray (1889), Trelease (1891), and Britton and Brown (1897) each reported the species from waste grounds at various places on the Massachusetts and Rhode Island coast and in the interior in New York state and Ontario.

EXPANSION OF THE RANGE

The range of *E. hirsutum* continued to expand in the early 1900's. In the state of New York, House (1924) and Wie-

gand and Eames (1926) both commented on its apparent recent introduction, and House (1924) reported it as "Becoming abundant in many sections of the State, where not observed a few years ago." Several specimens from the west central part of New York state document its occurrence in 1916 at McLean, Tompkins County (*Gershoy* 6854a, GH), at Conquest, Cayuga County (*Griscom & Wright* 6856, GH), at Cortland, Cortland County (*Munz & Wright* 6854, GH), and in 1918 at Fayette, Seneca County (*Evans* 10445, GH). Zenkert (1934) wrote "The progress of this species across New York State in the past twenty or thirty years has been rather rapid. It seems to have followed the waterways up the Mohawk and Seneca Rivers."

The willow-herb apparently was first found in Nova Scotia at Yarmouth in 1926 (*Groh s.n.*, CAN, DAO), but evidently the species was not reported for the Maritime Provinces until 1951, based on a later collection from Point Pleasant, Halifax, Nova Scotia, 1 August 1949 (Erskine, 1951). For Quebec the species was not reported by Marie-Victorin (1935) in his *Flore Laurentienne*. In a supplement to Marie-Victorin's *Flore*, Rouleau (1947) apparently first reported *E. hirsutum* for Quebec. The earliest known specimen comes from the "rivages du Saint-Laurent" at Les Cedres, between Melocheville and Coteau-du-Lac in 1940 (*Marie-Victorin et al.* 4292, CAN, F, GH, MO, NY, PH, US). Raymond and Kucyniak (1948) listed two additional stations downstream as far as the western limits of the city of Montréal where plants (specimens not seen) had been found in 1944 and 1945. They pointed out that the species, "first introduced in the region of Lake Ontario, has come into Quebec [from the southwest] along the route of migration followed by several native plants, such as *Allium canadense* and *Justicia americana*, . . . via the shores of the St. Lawrence river." Rousseau (1968) also confirmed Marie-Victorin's 1940 record and mapped the species' distribution for Quebec.

Several specimen records from localities along or near Lake Ontario document its early spread in Ontario in 1930

at Toronto, York County (*Brown* 1058, TRT), in 1933 at Port Hope, Durham County (*Pease & Bean* 23686, GH), in 1936 at Aberfoyle, Wellington County (*Stroud s.n.*, DAO, TRT), in 1939 at Bath, Lennox and Addington County (*Minshall* 417, DAO), and along the east end of Lake Erie in 1935 at Turkey Point, Norfolk County (*Bowden s.n.*, HAM), and in 1937 at Port Colborne, Welland County (*Simon s.n.*, TRT). In a 1953 survey of the St. Lawrence Seaway area, Dore and Gillett (1955) pointed out that *E. hirsutum* was becoming common in many marshy places and ditches, but only near the River and its adjacent main highway. Montgomery (1957) reported *E. hirsutum* as "a common weed in low lying and swampy areas in the southern counties" of Ontario. The species appears to be on its way to becoming thoroughly established in the southern Ontario marsh flora as evidenced by many collections in the 1940's, 1950's, and 1960's.

MIGRATION WESTWARD IN THE GREAT LAKES REGION

The great hairy willow-herb apparently moved into northeastern Ohio sometime before the 1930's. The first known collection was obtained in 1932 along Lake Erie in a swamp near Conneaut, Ashtabula County (*Hicks s.n.*, OS). Hicks, an active field botanist in Ohio in the 1930's, wrote on the label, "New Ohio Record." A specimen was obtained in 1938 farther west along the lake at Perry in Lake County (*Crofoot s.n.*, OS). The species has been found in six other northeastern Ohio counties as revealed by collections in The Ohio State University Herbarium from 1955 to 1958. Its occurrence westward along Lake Erie is more recent, where it was first found at Lighthouse Point at the north end of Pelee Island in 1959 (*Pinkava* 59194 and *Wells* 173, OS). Over the past several years further collections verifying the occurrence and spread of *E. hirsutum* have been obtained in western Lake Erie. In addition to those localities cited in Stuckey (1968a), the species has been found in northwestern Ohio in Erie County along old dike in marsh along west side of old Cedar Point Causeway at the NE

limits of Sandusky (*Stuckey* 8500, OS, 14 Sep 1969) ; in Ottawa County on mud flats along edge of marsh at East Harbor, East Harbor State Park (*Stuckey* 7359, GH, OS, 14 Aug 1968; *Stuckey* 8220, OS, 31 Jul 1969), in cat-tail marsh at Turtle Creek along roadside, SW corner of Sec. 5, T7N, R15E, Carroll Twp., ca. 6 mi N of Oak Harbor (*Stuckey* 7526, CAN, OS, 26 Aug 1968), on wet sandy beach, along edge of marsh, Sand Point, Marblehead Peninsula, ca. 2.5 mi S of the town of Marblehead (*Stuckey* 7684, OS, PH, 12 Sep 1968), and at edge of grape vineyard, south side of Fox's Marsh, North Bass Island (*Stuckey* 8205, OS, 29 Jul 1969; *Stuckey* 8288, OS, 28 Aug 1969) ; and in Monroe County, Michigan, where it was occasional in wet sand on beach along shore of Lake Erie, SW corner Sec. 35, Frenchtown Twp., N edge of Sterling Monroe State Park, E edge of the city of Monroe (*Stuckey* 7763, OS, 14 Sep 1968).

The first report for Michigan is that of Hanes (1945) based on plants found in 1943 in low ground near Portage, Kalamazoo County (*Becker* 4362, specimen not seen). A later collection comes from a marshy roadside, near Bay Port, Huron County in 1952 (*Hermann* 11778, GH, MICH). Since then *E. hirsutum* has been found in scattered locations in the Lower Peninsula of the state, several of which (from southeastern Michigan) are cited in Stuckey (1968a). The species has reached the Straits of Mackinac area where collections are known as early as 1953 (Voss, 1957a, 1957b). The species continues to persist in this area, based on a more recent collection, locally common along roadside in Mackinaw City, Emmet County (*Voss* 12950, OS, UMBS, 10 Aug 1969).

The farthest westward penetration for *E. hirsutum* in the Great Lakes region has been to northern Illinois (Steyermark & Swink, 1949) where plants were first found in 1948 at the water's edge along a ditch at the base of a railroad embankment in South Chicago, Cook County (*Steyermark & Swink* 65978, F, MO). In 1957 a specimen was collected along the Santa Fe Railroad south of Argonne National Laboratory at the southwest end of Rocky Glen Forest

Preserve, DuPage County (*Bartel* 7, F) Steyermark & Swink, 1959).

Epilobium hirsutum apparently has not reached other states bordering Lake Michigan and Lake Superior, for it is not reported for Indiana (Deam, 1940), Wisconsin (Ugent, 1963), or the counties of St. Louis and Lake in northeastern Minnesota (Lakela, 1965). It is evidently absent farther west because it is not recorded in recent checklists or floras for North Dakota (Stevens, 1950), Manitoba (Scoggin, 1957), Saskatchewan (Breitung, 1957), and Alberta (Moss, 1959).

EXPANSION IN THE SOUTHEAST PORTION OF THE RANGE

Since 1947 the willow-herb has been found at additional localities in northern New Jersey in 1949 at Patterson, Passaic County (*Schaeffer* 31092, PH), in eastern Pennsylvania in 1946 at Glenburn, Lackawanna County (*Glowenke* 8573, GH), in 1947 at Treichlers, Northampton County *Schaeffer* 26937a, PH), in 1967 at Temple, Berks County (*Wilkens* 12793, PH), and in Maryland along railroads near Chesapeake Bay, in 1955 at Baltimore (*Baltar* 635, US) and in 1960 at Magnolia, Harford County (*Baltar* 2735, US). Reed (1964) cited collections from a large patch in wastes (*Reed* 39575, Oct 1957) and on chrome ore piles (*Reed* 45712, Oct 1959) both at Canton in the port of Baltimore, Maryland. *E. hirsutum* has not been reported farther inland from such places as Centre and Huntingdon Counties, Pennsylvania (Westerfield, 1961), and West Virginia (Strausbaugh & Core, 1958), or in the coastal states of Virginia (Massey, 1961) and North and South Carolina (Radford, Ahles, & Bell, 1968).

OCCURRENCE IN THE STATE OF WASHINGTON

In the state of Washington, *E. hirsutum* was found in 1965 in wet ground at edge of railroad track near Bellingham, Whatcom County (*Sutherland* 1084, CAN) and in 1966 abundant along a ditch beside a highway at Bingen, Klickitat County (*Spellenberg & Sutherland* 1191, NY). The oc-

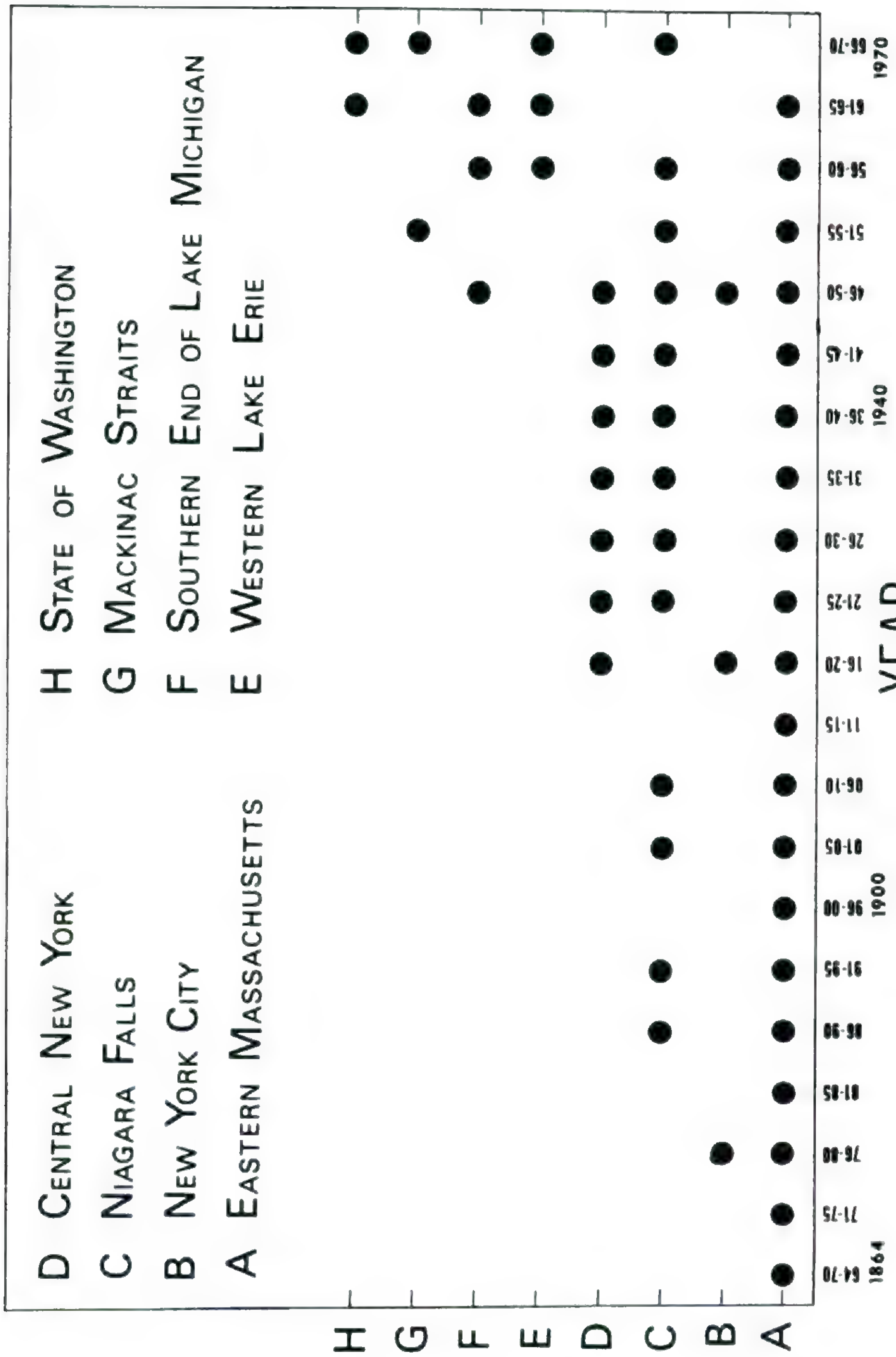

Fig. 3. Dates of Herbarium Specimens Verifying the Time of Spread and Establishment of *Epilobium hirsutum* in Eight Floristic

currences of this species in Washington probably represent recent introductions separate from its migration and spread in eastern North America.

PRESENT STATUS IN NORTHEASTERN UNITED STATES

Although the previous discussion and the map (fig. 2) give the early occurrences of *E. hirsutum* in various states or areas on the continent, there is no indication whether the species has become established in these areas. At Newport, Rhode Island, the locality of the oldest collection, several specimens are known from 1829 to the most recent seen obtained in 1959 (*Eaton s.n.*, NEBC). These records therefore confirm the establishment of the species in this area. Many specimens in the New England Botanical Club, New York Botanical Garden, and Gray Herbaria document its establishment and spread on Nantucket Island. Bicknell (1914) stated that *E. hirsutum* was "Common in the lower parts of town and out into the suburbs, often massed along ditches and in corners of damp lots and low fields; also by the roadside in Shawkeno, the only place where I saw it far from town . . ." By 1958, according to Mackeever (1961), *E. hirsutum* has spread throughout the island. In a check-list of the vascular plants of Maine (Ogden, Steinmetz, & Hyland, 1948), Cumberland County continues to be the only locality for its occurrnce in that state. In the New York City area Monachino (1959) reports that the great hairy willow-herb "is now frequent and locally abundant . . ."

Through the years certain localities or general areas have been studied floristically rather frequently and more thoroughly than other areas by botanists. Within the present range of *E. hirsutum*, eight of these "rather well-studied floristic areas" were selected. Each area is defined geographically by several counties as given in table 1 and by the fact that one or more local floras or checklists of plants have been prepared for each area prior to obtaining the first known record of *E. hirsutum*. In figure 3 these floristic

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Areas of North America. Each dot represents one or more herbarium specimens collected within a five-year period for each floristic area.

areas are listed on the vertical axis and time is represented on the horizontal axis. All specimens or records of specimens examined from these areas are each marked with a dot along the horizontal axis at the corresponding five-year interval of their collection. Figure 3 shows (1) the earliest specimen record known for each floristic area, (2) that the species has become established in each floristic area, because specimens have been found and obtained, in the years following the original collection and even up to the present time in certain areas, and (3) the gradual progression and establishment of *E. hirsutum* from the northeast coast of the United States, through central New York state, and into the Great Lakes region.

FUTURE EXPANSION OF THE RANGE

Since 1929, *E. hirsutum* has expanded its range throughout northeastern United States and into the Great Lakes region. It therefore would be expected that *E. hirsutum* should continue to expand its distribution on the North American continent into localities with habitats similar to those where the plants have already become established. The present range of *E. hirsutum* has approximately the same general range in North America that *Rorippa sylvestris* had about 1900 (Stuckey, 1966). *R. sylvestris*, a species that occurs in habitats (waste places, gardens, marshes, ditches, and along rivers) similar to those of *E. hirsutum*, has since 1900 spread farther westward into Wisconsin, Iowa, and North Dakota, and southward into Virginia, West Virginia, Ohio, Indiana, Illinois, and Missouri. Given another 70 years, perhaps *E. hirsutum* will spread to an extent that its range may be similar to that of *R. sylvestris* today. Where both species are native and have had considerable time for spreading in Europe, they both have similar distributions, although *E. hirsutum* is absent in the extreme north (Valentine, 1964; Raven, 1968). Jonsell (1968, p. 97-103) discusses the distributional history of *R. sylvestris* in Scandinavia and shows that its range has been expanding northward over the past 100 years. Comparative migration

rates and distributional patterns, as illustrated by these two species in North America, should be useful for predicting areas to where and when other non-indigenous shore and marsh species may or may not migrate. However, our knowledge for making these kinds of comparisons is meager because the distributional histories of many of the species have not yet been worked out.

ACKNOWLEDGMENTS

I am grateful to Mr. Richard Hendricks for assembling the data from the literature and several herbaria and preparing a preliminary version of the map. My thanks are extended to those herbaria (DAO, GH, MICH, MO, NEBC, NY, OS, PH, and US) whose specimens were examined. Records of herbarium specimens have been provided by Dr. James Wells (BLH), Dr. James Soper (CAN), Mr. Richard Lowden (F), Dr. James Pringle (HAM), Dr. James Cruise (TRT), and Dr. Edward G. Voss (UMBS). Mary R. Norcross and Elsa Prediga have contributed information from the Maria Mitchell Science Library, Nantucket, Massachusetts. The field study in the western Lake Erie area was conducted as part of the teaching and research program at The Franz Theodore Stone Laboratory, Put-in-Bay, Ohio, during the summers of 1967, 1968, and 1969. Additional support for field work has been provided by The Ohio Biological Survey. I am thankful to Mr. Ronnie Johnson, Mr. W. Alan Wentz, and Mr. Thomas Duncan who served as field assistants, and to Mr. William H. Anderson who printed the photograph and map for publication.

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Table 1. Well-Studied Floristic Areas Within the Present Range of *E. hirsutum*.

Eastern Massachusetts Area
: Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, and Suffolk Counties, Massachusetts.

New York City Area
: Bronx, Kings, Nassau, New York, Queens, Richmond, Suffolk, and Westchester Counties, New York; Bergen and Passaic Counties, New Jersey.

Niagara Falls Area
: Erie, Genesse, Niagara, and Orleans Counties, New York; Halton, Lincoln, Peel, Welland, Wentworth, and York Counties, Ontario.

Central New York Area
: Cayuga, Chemung, Cortland, Madison, Monroe, Onondaga, Seneca, Tompkins, and Wayne Counties, New York.

Western Lake Erie Area
: Erie, Lucas, Ottawa, and Sandusky Counties, Ohio; Monroe and Wayne Counties, Michigan; Essex and Kent Counties, Ontario.

Southern End of Lake Michigan Area
: Cook, DuPage, and Lake Counties, Illinois; Lake, Laporte, and Porter Counties, Indiana; Berrien and Van Buren Counties, Michigan.

Mackinac Straits Area
: Cheboygan, Emmet, and Mackinaw Counties, Michigan.

State of Washington
: Klickitat and Whatcom Counties.

A RE-EVALUATION OF POLYGONUM MEISNERIANUM IN NORTH AMERICA[1]

RICHARD S. MITCHELL

In eastern North America the two widespread species of *Polygonum*, section Echinocaulon, are *P. sagittatum* and *P. arifolium*. These are known by their retrorse barbs, sprawling habit and sagittate to hastate leaves. A third entity, *Polygonum meisnerianum* C. & S. var. *beyrichianum* (C. & S.) Meisn., has gone almost unnoticed, although it was first collected in the United States over 140 years ago. It is one of the widest ranging aquatic angiosperms in the western hemisphere, and is unusual in that it simulates members of section Persicaria in both leaf shape and erect-emergent habit. Retrorse barbs and inflorescence type link *P. meisnerianum* with other "Tear-thumbs" (Echinocaulon) ; however, its center of distribution and nearest phylogenetic relationships are in eastern South America, not in Asia, as is the case for both *P. sagittatum* and *P. arifolium*.

The purpose of this paper is to bring knowledge of *P. meisnerianum* out of its present state of obscurity, so that the species may now be recognized by manuals and floristic treatments in the southern United States. Two collections from Florida and one from South Carolina are also reported here, and a variety based upon phenotypic modification is placed in synonymy.

Historical Account

Polygonum meisnerianum and *P. beyrichianum* were first described by Chamisso and Schlechtendal (1828) from materials collected on a Brazilian expedition. A few years later, Chamisso (1833) described two additional related species, *P. rubricaule* and *P. stelligerum*. Thus, by 1833 there were four published species descriptions with char-

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acters distributed among members of a group of closely inter-related taxa. This species-complex has its center of distribution in Brazil and Argentina. A number of names have been applied in Latin America since 1833, but most are synonyms whose descriptions add no new diagnostic information. A list of pertinent synonymy appears in the treatment to follow.

Meisner, in Martius' flora of Brazil (1855), reduced *P. beyrichianum* to varietal status, listing the name *P. meisnerianum* C. & S. var. *beyrichianum* (C. & S.) Meisn., which is now the most widely accepted combination. There seems to be sufficient intermediacy in some Brazilian and Argentinian specimens to warrant this change, and the problem is still in need of study; however, plants designated "var. *beyrichianum*" do occur in typical morphological form throughout Brazil and Argentina, extending to Central America, Mexico, Cuba and at least three states in the United States.

The first person to collect *P. meisnerianum* in the United States was T. Drummond, whose specimen number 177 is cited, without date, by Meisner (1855). This specimen, supposedly from Texas, has not been found by the author, but Drummond's number 277, dated 1832, from New Orleans, was found at both the Gray Herbarium of Harvard University and the U. S. National Herbarium.

Specimens collected by J. L. Riddell in Louisiana are partially without dates, but the earliest seems to be August 13, 1838, from Madisonville, Louisiana. He noted in parentheses that the species was undescribed, but labeled it *P. geniculatum* Ridd., a name which he then published in de Candolle's *Prodromus*.

The species was omitted from Chapman's *Flora of the Southeastern States* (1889).

A. B. Langlois collected the plant in 1885 and again in 1892, both times in Louisiana. He noted that it "is pronounced a rare plant."

J. K. Small, in his monograph of North American *Polygonum* (1895), illustrated and re-described specimens under

the correct name of *P. meisnerianum* var. *beyrichianum*. It is surprising that this taxon was omitted from his *Manual of the Southeastern Flora* (1933).

Collections of this species have been extremely infrequent in North America since the turn of the century. There are no sheets of it in the herbaria of the University of Texas, Southern Methodist University or Texas Research Foundation, where the aquatic flora of the southwestern states is being studied extensively. There are also no specimens at Louisiana State University or Southeastern Louisiana State University.

In the summer of 1968, I found *P. meisnerianum* var. *beyrichianum* growing at the south end of Lake Miccosukee on the Leon-Jefferson line in Florida. It had been collected once before in northern Florida (D. B. Ward, personal communication) in 1935 by Erdman West, at Newnan Lake in Alachua County. These two stations establish firmly its natural occurrence in Florida, and it has now been included in the Florida checklist.

Recently a state record for South Carolina was collected, but went unnoticed. It was found in Jasper County (S. W. Leonard #2231, and A. E. Radford) in a wet ditch on Highway 601, 1.4 miles north of County road 27-169. The specimens are labelled "*P. sagittatum* L.; unusually narrow leaves".

With the occurrence of *P. meisnerianum* in Florida, Cuba and South Carolina established, the North American distribution of the species may best be described as sporadic around the Gulf of Mexico. The migration route from South America was probably along the expanded coastal plain during the Pleistocene pluvials. The direction of migration is now in doubt, however, since the occurrence of the species in the West Indies, Florida and South Carolina opens up the possibility of an eastern route.

Morphological Transformation

Polygonum meisnerianum var. *beyrichianum* differs from the typical variety of the species as well as its other South

Fig. 1. *Polygonum meisnerianum* C. & S. var. *beyrichianum* (C. & S.) Meisn., a wide-ranging South American aquatic which reaches its northern limits of distribution in Florida, Louisiana and South Carolina. A. habit, showing dichotomously branching inflorescence. B. inflorescence, with glandular petioles. C. nodal region with sheathing stipule (ocrea), clasping leaf base and retrorse barbs. D. trigonous achene.

American relatives in having sessile, slightly auriculate leaves rather than petiolate, sagittate ones. A sagittate-leaved variety, *P. meisnerianum* C. & S. var. *jalapense* Robins., was described in 1900 from Mexico. On examination, the type specimen shows a dense covering of glandular hairs on leaves, petioles and stems, and no barbs or other pubescence.

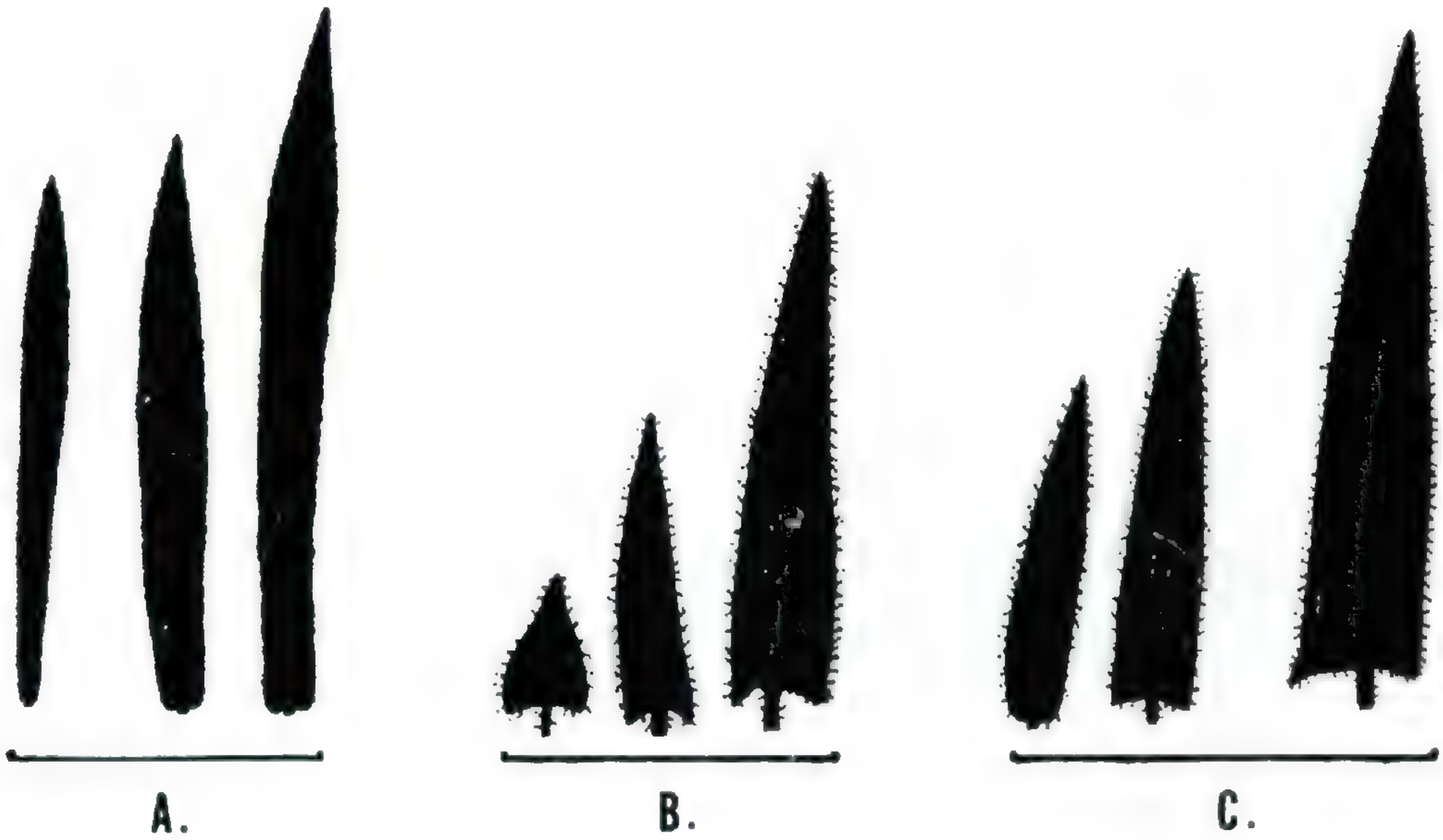

Fig. 2. Leaf silhouettes as evidence that *Polygonum meisnerianum* var. *jalapense* is a name based upon a phenotypic modification of var. *beyrichianum*. A. leaves from *P. meisnerianum* var. *beyrichianum* collected in Florida. B. juvenile leaves from rhizomes of the same plants after being cut back and grown in the greenhouse. These leaf types persisted for months. C. leaves from the type specimen of *P. meisnerianum* var. *jalapense*.

Mass collections of var. *beyrichianum* sent from Florida by R. K. Godfrey in 1969 showed typical leaf morphology throughout (Fig. 1); however, rhizomes of these plants, cut back and shipped live, gave surprising results when grown in a Virginia greenhouse. Young shoots produced only sagittate leaves with substantial petioles. The leaves and stems were covered with glandular hairs and lacked barbs or other pubescence. Thus, var. *beyrichianum* simulated the type specimen of var. *jalapense* almost exactly in its juvenile growth (Fig. 2), and continued to do so for many months after its disturbance and etiolation. It is now clear that "var. *jalapense*" can be induced environmentally, and should not retain taxonomic status. This atavistic manifestation also gives good evidence that the leaf type of var. *beyrichianum* is a derived condition, and that this variety has evolved from plants with sagittate leaves.

Pertinent Synonymy

Polygonum meisnerianum var. *beyrichianum* appears, at present, to be the only species and variety of the South American Tear-thumb group which occurs in North America. It is listed here with its Brazilian relatives and the most frequently used synonyms for the group.

1. *Polygonum meisnerianum* C. & S. var. *meisnerianum*, Linnaea, 3: 42. 1828.
2. *Polygonum meisnerianum* C. & S. var. *beyrichianum* (C. & S.) Meisn., in Martius' Fl. Bras., 5: 19. 1855.
   P. beyrichianum C. & S., Linnaea 3: 42. 1828.
   P. multiangulare H. & A., Comp. Bot. Mag. 2: 62. 1836.
   P. geniculatum Ridd. ex Meisn., DC. Prodromus, 14: 42.
   P. chamissoanum Wedd. (non Steud.), Ann. Sci. Nat. 3(8) : 254.
   P. türkheimii Vatke ex Small, Bull. Torr. Bot. Club 19: 370. 1892.
   P. meisnerianum C. & S. var. *jalapense* Robins., Proc. Amer. Acad. 3: 324. 1900.
3. *P. meisnerianum* C. & S. var. *usterianum* Mattos, Loefgraenia 22: 2. 1965.
4. *Polygonum rubricaule* Cham., Linnaea 8: 130. 1833.
5. *Polygonum stelligerum* Cham., Linnaea 8: 131. 1833.
   P. acanthophyllum Lindau, Botan. Jahrb. 19(48) : 12. 1894.
   P. meisnerianum C. & S. var. *setosum* Chod. & Hass. Bull. Herb. Boiss. ser. 2, 3: 392. 1903.

In addition to the preceding list there are also combinations under the genus *Tracaulon*.

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SMALL, J. K. 1895. A monograph of the North American species of *Polygonum*. Mem. Dept. Bot., Columbia College, 1, 183 pp.
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ERAGROSTIS PLANA IN SOUTH CAROLINA. — *Eragrostis plana* Nees has been collected twice (*Ahles & Haesloop* 52789 in 1959, NCU; *Ahles & Haesloop* 53840 in 1960, NCU) on "waste ground around the Santee Wool Combing Mill" at Jamestown, South Carolina. This stout, cespitose perennial, with linear, many-flowered spikelets, and glandular-punctate lemma nerves, is reported by Chippendahl [1955, A guide to the identification of grasses in South Africa (part I of *The grasses and pastures of South Africa*). Cape Times Limited, Parow., C.P., p. 316] to grow in South Africa and "tropical Africa". There are no previous records of its occurrence in North America. The grass apparently is closely related to the weedy annual *Eragrostis cilianensis* (All.) Lutati [*E. megastachya* (Koel.) Link] which also has spikelets with many florets and glandular-punctate lemma nerves. Of special note on the Jamestown specimens is the occasional occurrence of 5 strong (glandular-punctate) nerves on the lemma. This characteristic was not noted by Chippendahl and is the first variation known to the writers from the remarkably consistent 3-nerved condition of the *Eragrostis* lemma.

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AN UNDESCRIBED SPECIES OF ASTRAGALUS (LEGUMINOSAE) FROM UTAH

STANLEY L. WELSH

An examination of additional materials of *Astragalus* section DESPERATI subsection NATURITENSIS from San Juan County, Utah has demonstrated the need for re-evaluation of the specimens passing under the name *A. monumentalis* Barneby (1953, 1964). Materials included under that epithet can be segregated into two entities on the basis of differences in calyx size and shape, petal length, and pod size and shape. The species can be distinguished by the following key.

Calyx tube cylindric, 4.8-6.7 mm. long; flowers 11-17 mm. long; pods 20-25 mm. long, conspicuously arcuate. ..... *A. cottamii.*

Calyx tube campanulate, 3-3.5 mm. long; flowers 8-9 mm. long; pods 12-21 mm. long, straight to somewhat curved. ..... *A. monumentalis.*

Astragalus cottamii Welsh sp. nov.

A. *A. monumentale* differt calycis tubo longiore cylindrico, floribus longioribus, et leguminibus longioribus et curvatis magis.

Herba perennis radice palari et caudicibus ramificantibus (interdum florens tempa prima); caules 0.5-6 cm. longi, ascendentes; stipulae 2-6 mm. longae, membranaceae, amplectentes sed non connatae; folia 1.2-8 cm. longa, petiolis persistentibus, foliola (5) 9-19 (21), 2-9 mm. longa, 1-4.2 mm. lata, elliptica ad ovalia vel oblanceolata, strigulosa pilis simplicibus, saepe plicata; pedunculi 0.7-7 cm. longi; racemi 3-9 floribus, rhachidibus 0.5-2 cm. longi; bracteolae 2, minutae vel nullae; tubus calycis cylindricus, 4.8-6.7 mm. longus, strigulosus, purpureo-suffusus, dentes 1.2-2 mm. longi, subulati; flores 11-17 mm. longi, petala purpureo-rosea, vel vexillum pallens; legumina 20-25 mm. longa, 2.5-4 mm. lata, valde curvata, oblonga ad oblongo-lanceolata, triquetra, sutura ventralis prominens, dorsalis sulcata pro-

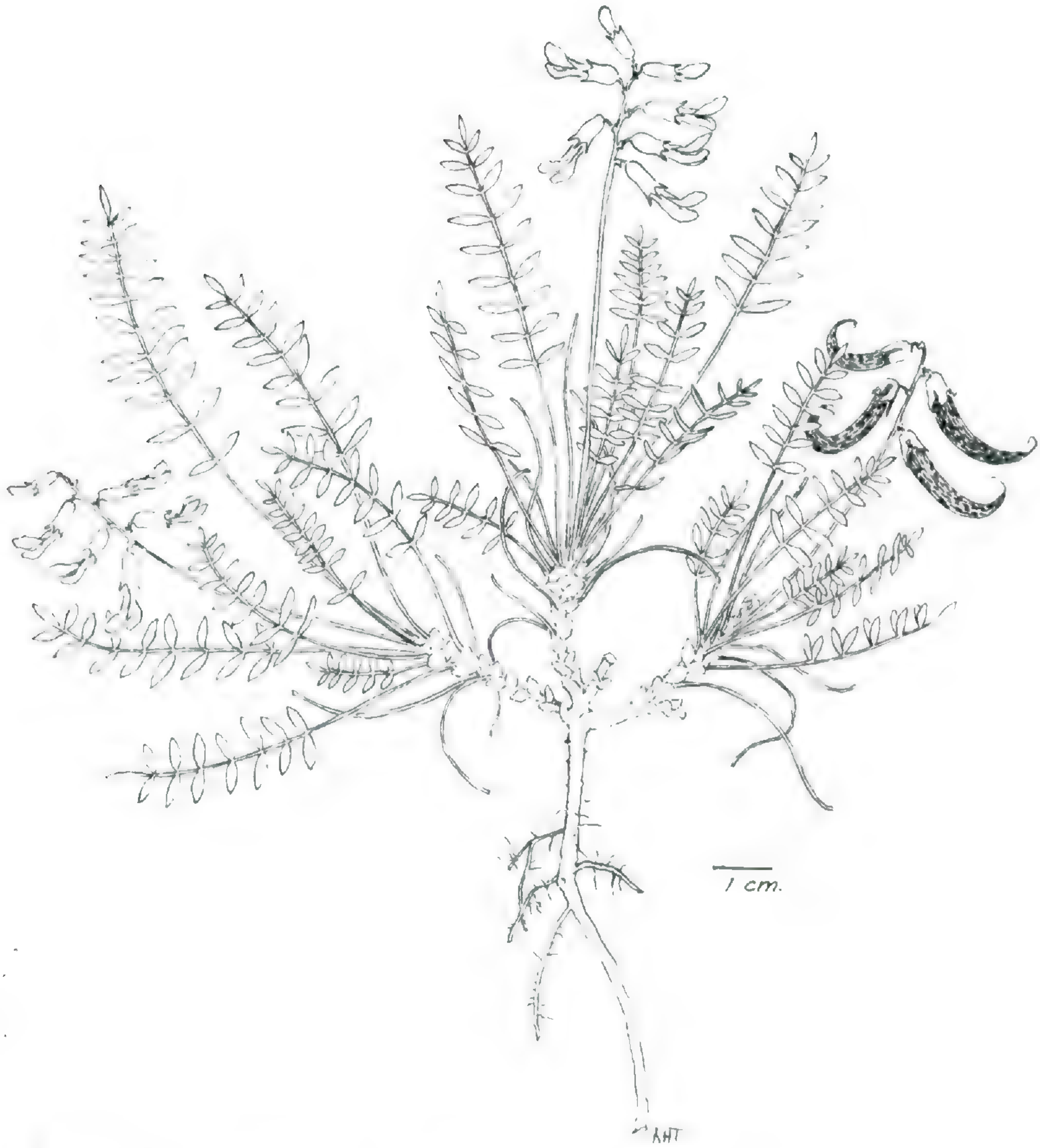

Figure 1. *Astragalus cottamii* Welsh, habit.

funde, bilocularia sutura dorsali ab intrusa, purpureo-maculata, strigulosa.

UTAH: SAN JUAN CO., ca. 4 miles east of Clay Hills Divide, *S. L. Welsh* 5207, 1 May 1966 (Holotype, BRY, Isotypes ISC, NY). Comb Ridge 16 miles west of Blanding, *R. C. Barneby* 12783, 19 May 1955 (UTC), *S. L. Welsh et al* 8931, 8 May 1969 (BRY). Natural Bridges National Monument, *S. L. Welsh* 5187, 5188, 20 April 1966, *B. F. Harrison* 5922, 7 May 1933, *S. L. Welsh et al* 8948, 9 May 1969 (BRY). Comb Wash, *S. L. Welsh et al* 8932, 8938, 9 May 1969 (BRY). Bluff, *W. P. Cottam* 5825, 29 April 1935 (BRY).

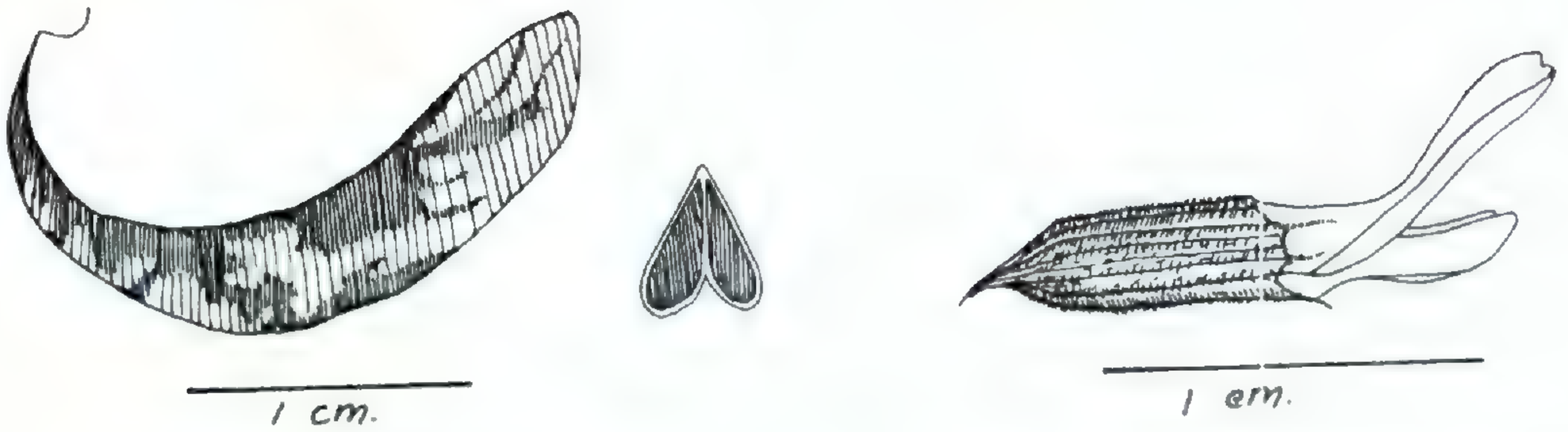

Figure 2. *Astragalus cottamii* Welsh, detail of flower and fruit.

The Cottam milk-vetch grows in sandy soil in weathered depressions and crevices on exposed rimrock and ledges of the Cedar Mesa (Permian), Kayenta (Jurassic), and Entioda (Turrassic) formations, and less commonly on sandy alluvium derived from those formations. It is known to occur from the vicinity west of Clay Hills Divide on the road to Halls Crossing north-eastward to Natural Bridges National Monument and eastward to Bluff. *Astragalus monumentalis* occurs in similar habitats but is apparently restricted to the Cedar Mesa Formation from Fry Canyon (a tributary of White Canyon) westward along the Cedar Mesa Formation to where that formation dips beneath younger strata west of the Colorado River in Garfield Co., Utah, and northward to the Needles area of Canyonlands National Park.

The species is named in honor of Dr. Walter P. Cottam, botanical collector, plant ecologist, and teacher.

The altered *A. monumentalis* represents a more discrete entity with the exclusion of the specimens which form *A. cottamii*. A description and list of specimens of *A. monumentalis* is provided for comparison.

Astragalus monumentalis Barneby Leafl. West. Bot. 7: 35. 1953.

Perennial herb with taproot (sometimes flowering the first season) and branching caudex; stems 1-6 cm. long, ascending; stipules 2-4 mm. long, membranous, clasping but not connate around the stem; leaves 1.5-8(11) cm. long, with persistent petioles; leaflets (5) 9-17(21), 2-9

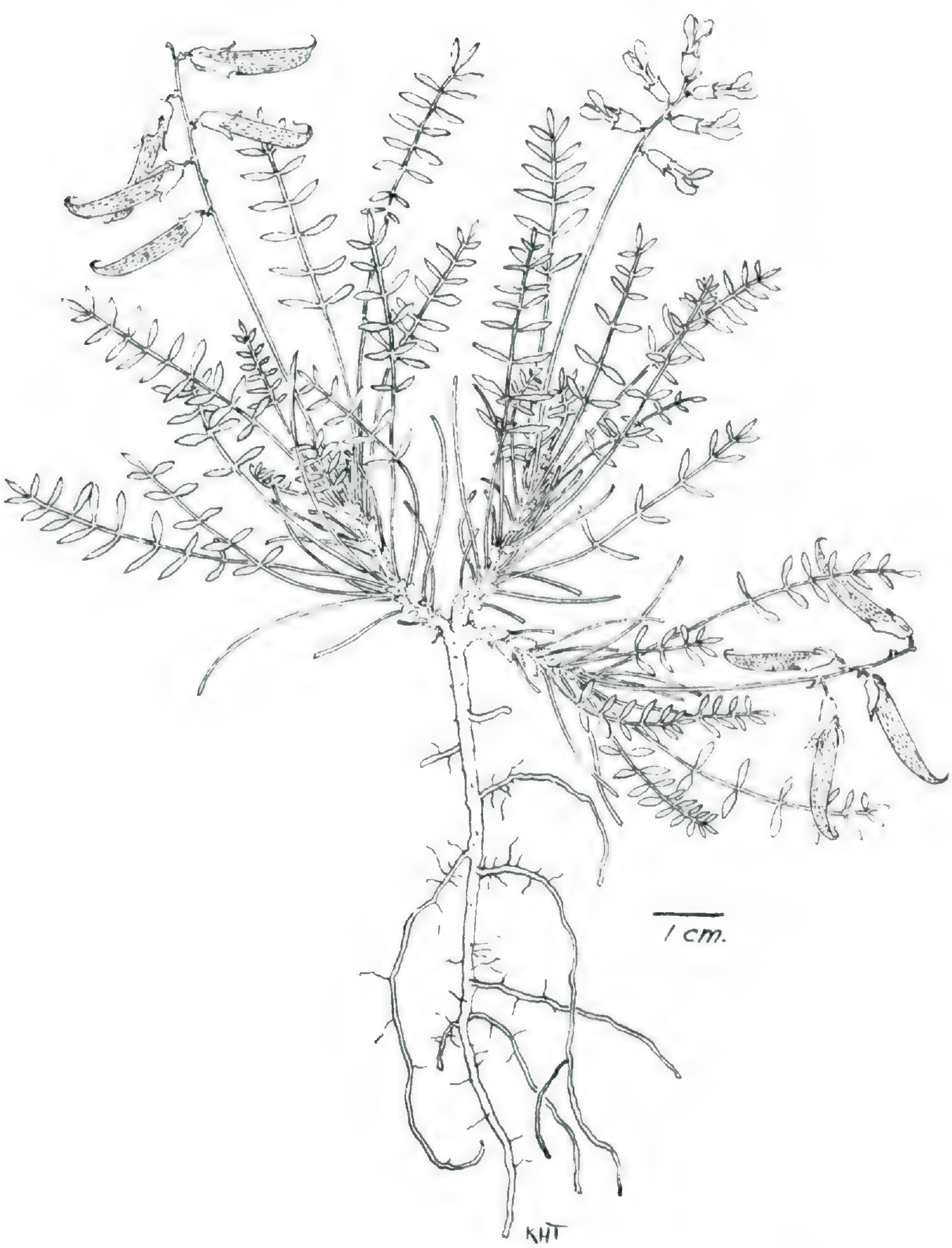

Figure 3. *Astragalus monumentalis* Barneby, habit.

mm. long, 1-4 mm. broad, oval to obovate, elliptic, or oblanceolate, strigulose with simple hairs, often folded; peduncles 1-12 cm. long; racemes 3- to 9- flowered, the rachis 0.5-7 cm. long in fruit; bracts longer than the pedicels; bracteoles lacking; calyx tube campanulate 3-3.5 mm. long, strigulose,

Figure 4. *Astragalus monumentalis* Barneby, detail of flower and fruit.

purplish-tinged, the teeth 0.5-1 mm. long, triangular; flowers 8-9 mm. long, the petals pink-purple; pods 12-21 mm. long 2.3-3 mm. broad, straight to curved, triangular in cross-section, the ventral suture prominent, the dorsal deeply sulcate, 2-loculed by intrusion of dorsal suture, greenish or purplish-mottled, strigulose.

UTAH: SAN JUAN CO.; White Canyon, ca. 25 miles southwest of Hite, *B. F. Harrison* 11595, 18 May 1950 (BRY, Isotype). Fry Canyon, *S. L. Welsh* 5191, 29 April 1966 (BRY, ± Topotype). Ca. 8 miles west of Fry Canyon, *S. L. Welsh* 5212, 1 May 1966 (BRY). Canyonlands National Park; Virginia Park, *G. Moore* 307, 14 May 1965 (BRY), Squaw Flat, *G. Moore* 348, 348a, 15 May 1965 (BRY), *S. L. Welsh et al* 2954, 1 June 1964 (BRY), Chesler Park, *S. L. Welsh et al* 2901, 1 June 1964 (BRY), west side of Elephant Hill, *S. L. Welsh et al* 2888, 31 May 1964 (BRY), vicinity of Silver Stairs, *S. L. Welsh* 7030, 15 May 1968 (BRY). GARFIELD CO.: west side of Colorado River Bridge near Hite, *Welsh* 5214, 1 May 1966 (BRY), *S. L. Welsh and G. Moore* 7122, 28 May 1968 (BRY).

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INVESTIGATIONS OF NEW ENGLAND MARINE ALGAE III COMPOSITION, SEASONAL OCCURRENCE AND REPRODUCTIVE PERIODICITY OF THE MARINE RHODOPHYCEAE IN NEW HAMPSHIRE[1]

EDWARD J. HEHRE[2] & ARTHUR C. MATHIESON

There are few published accounts of the marine algae in New Hampshire (Farlow, 1882; Collins, 1900, 1901, 1903, 1906; Croasdale, 1941; Wood and Straughan, 1953; Doty and Newhouse, 1954). Mathieson, Hehre and Reynolds (in press) have reviewed pertinent literature on the distribution and phenology of New England marine algae and have described the seasonal occurrence and vertical distribution of 99 species of marine algae at Jaffrey Point, New Hampshire. Mathieson, Reynolds and Hehre (in press) have recorded distributional patterns of marine algae in the Great Bay Estuary System.

The present paper is the culmination of a three year study of the Rhodophyceae in both coastal and estuarine environments. The purpose of the study is three-fold: (1) to describe the composition of the red algal flora of New Hampshire; (2) to record the seasonal occurrence of the Rhodophyceae of New Hampshire; (3) to determine the reproductive periodicities of as many taxa as possible.

Monthly collections were made from 1966-1968 at ten locations along the New Hampshire coast (Fig. 1). Prior to 1966, only irregular collections were made at each station. Sixty-two stations were established in the Estuary during the summer of 1966, eight of which were monitored approximately monthly from 1966-1968 (Fig. 1). Extreme winter conditions prohibited access during certain months.

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[1]Published with the approval of the Director of the University of New Hampshire Agriculture Experiment Station as Scientific Contribution Number 479.

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Although monthly collections were not made at the Isles of Shoals, and the collections are somewhat minimal, all but Duck, White and Seavey Islands are represented. The Isles of Shoals are within New Hampshire and Maine (Fig. 2), but are referred to as a single unit because of their close proximity.

The methods of collection and identification of specimens are similar to those of Parts I & II. The nomenclature of the second revised British Checklist (Parke and Dixon, 1968) has been applied whenever possible. The classification of the Acrochaetiaceae follows Papenfuss (1947). All collections not otherwise specified have been deposited in the Algal Herbarium at the University of New Hampshire (NHA). The principal individual collectors are designated as follows: E. J. Hehre (H) and A. C. Mathieson (M).

The general algal collections, Algae Exsiccatae Americae-Borealis (Farlow, Anderson, and Eaton), and the volume of Phycotheca Boreali-Americana (Collins, Holden and Setchell, 1895-1919) at the Farlow Herbarium (FH) at Harvard University were examined. All previously published records on the Rhodophyceae of New Hampshire were consulted.

Collecting Locations on New Hampshire Coast

The New Hampshire coastline (Fig. 1) is approximately 18 miles long. The southern boundary is Seabrook Beach (42°52′30″ N, 70°49′ W); the boundary to the north is the mouth of the Piscataqua River at the entrance to Portsmouth Harbour (43°04′20″ N, 70°42′42″ W). A brief description of each station is summarized below.

Jaffrey Point (Fig. 1, Station 1) a semi-exposed site consisting of massive rock outcrops and many large eulittoral tidepools. The eulittoral and sublittoral fringe zones are well developed. An artificial breakwater, composed of large granitic blocks, provides excellent substrate.

Fort Constitution (Fig. 1, Station 2) is a sheltered location within the entrance to Portsmouth Harbour. The substrate consists of small rock outcrops, mud and sand. The vegetation is sparse. *Zostera marina* L. var. *stenophylla*

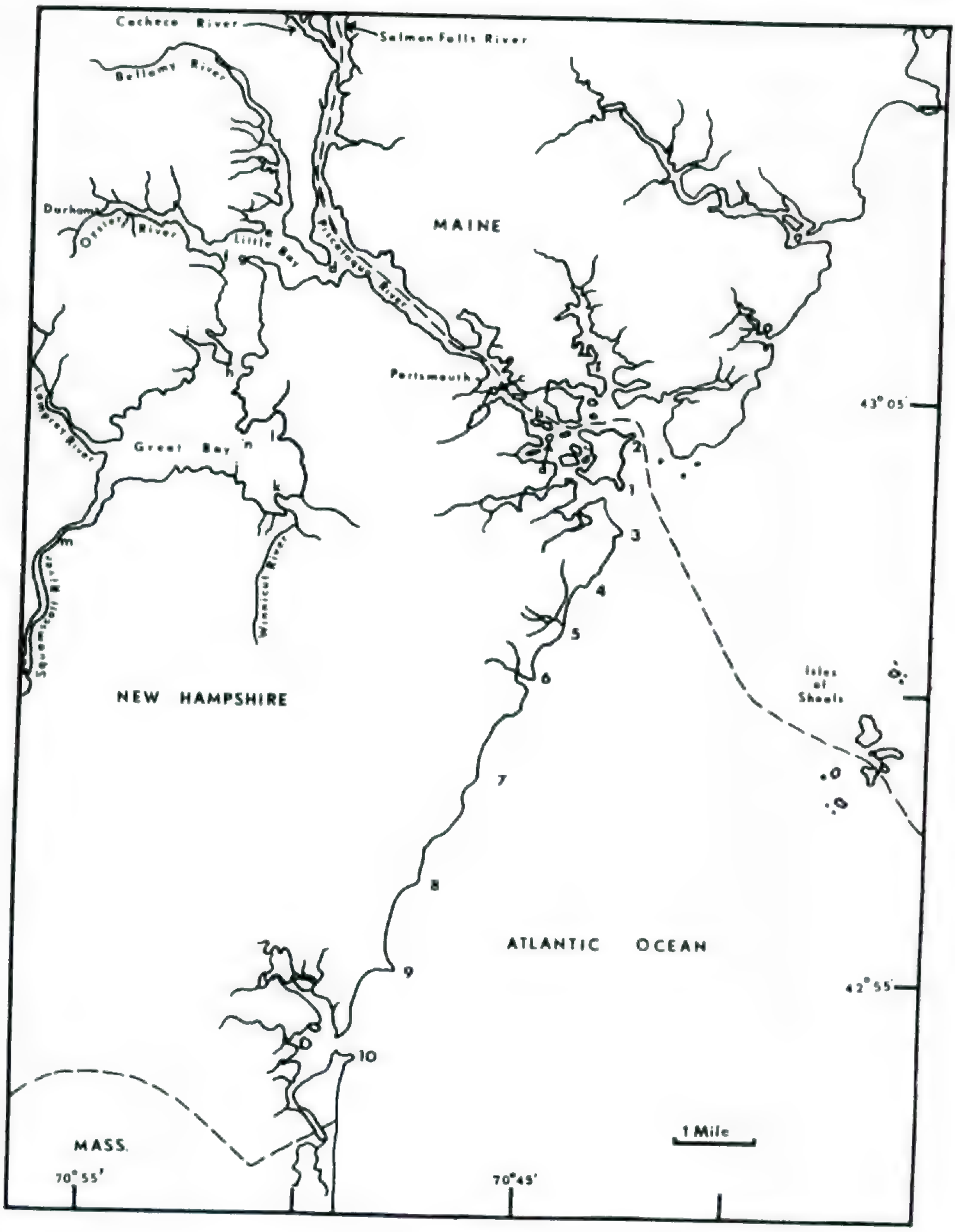

Figure 1
The New Hampshire Coast and
Great Bay Estuary System

COASTAL STATIONS:

1. Jaffrey Point, 2. Fort Constitution, 3. Odiorne's Point, 4. North Wallis Sands, 5. Concord Point, 6. Ragged Neck, 7. Rye Ledge, 8. Little Boar's Head, 9. Great Boar's Head, 10. Bound Rock.

Aschers. *et* Graebn. grows on the New Hampshire Coast only at Fort Constitution and Rye Ledge.

Odiorne's Point (Fig. 1, Station 3) is a semi-exposed beach with two distinct regions: a cobble area that supports little vegetation, and an area of rock outcrops which has a well developed flora.

North Wallis Sands (Fig. 1, Station 4) consists of massive rock outcrops on a sandy beach. Little vegetation is present.

Concord Point (Fig. 1, Station 5) is a semi-exposed site with two basic types of substrate: a cobble beach area, which is almost devoid of vegetation, and an area with massive rock outcrops. Except for the plants growing in occasional tidepools in the latter region, the vegetation is poor.

Ragged Neck (Fig. 1, Station 6) is a cobble beach at Rye Harbour. No tidepools are present and the vegetation is poor. A breakwater delimits the harbour entrance and supports a good flora.

Rye Ledge (Fig. 1, Station 7) is an exposed site consisting of massive rock outcrops and an area of large boulders and cobbles. Tidepools are common and a well developed sublittoral fringe is present. A rich algal flora is evident.

Little Boar's Head (Fig. 1, Station 8) is a semi-exposed cobble beach with scattered boulders and occasional rock outcrops. A few tidepools are present in the low eulittoral zone. The flora is poor.

Great Boar's Head (Fig. 1, Station 9) is a cobble beach with numerous large boulders. The flora in the eulittoral zone is poorly developed, but there is a good sublittoral fringe zone. Topographically Great Boar's Head is an exposed site, but its eulittoral vegetation, which is conspicuously dominated by fucoids, is indicative of a sheltered

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ESTUARY STATIONS:

a. Shapleigh Island, b. Pierce Island, c. Piscataqua River toll bridge, d. Hilton Park, e. Cedar Point, f. Durham Point, g. Fox Point, h. Adams Point, i. Crommet Creek, j. Weeks Point, k. Pierce Point, l. Fabyans Point, m. Squamscott River at Route 108, n. Nannie Island.

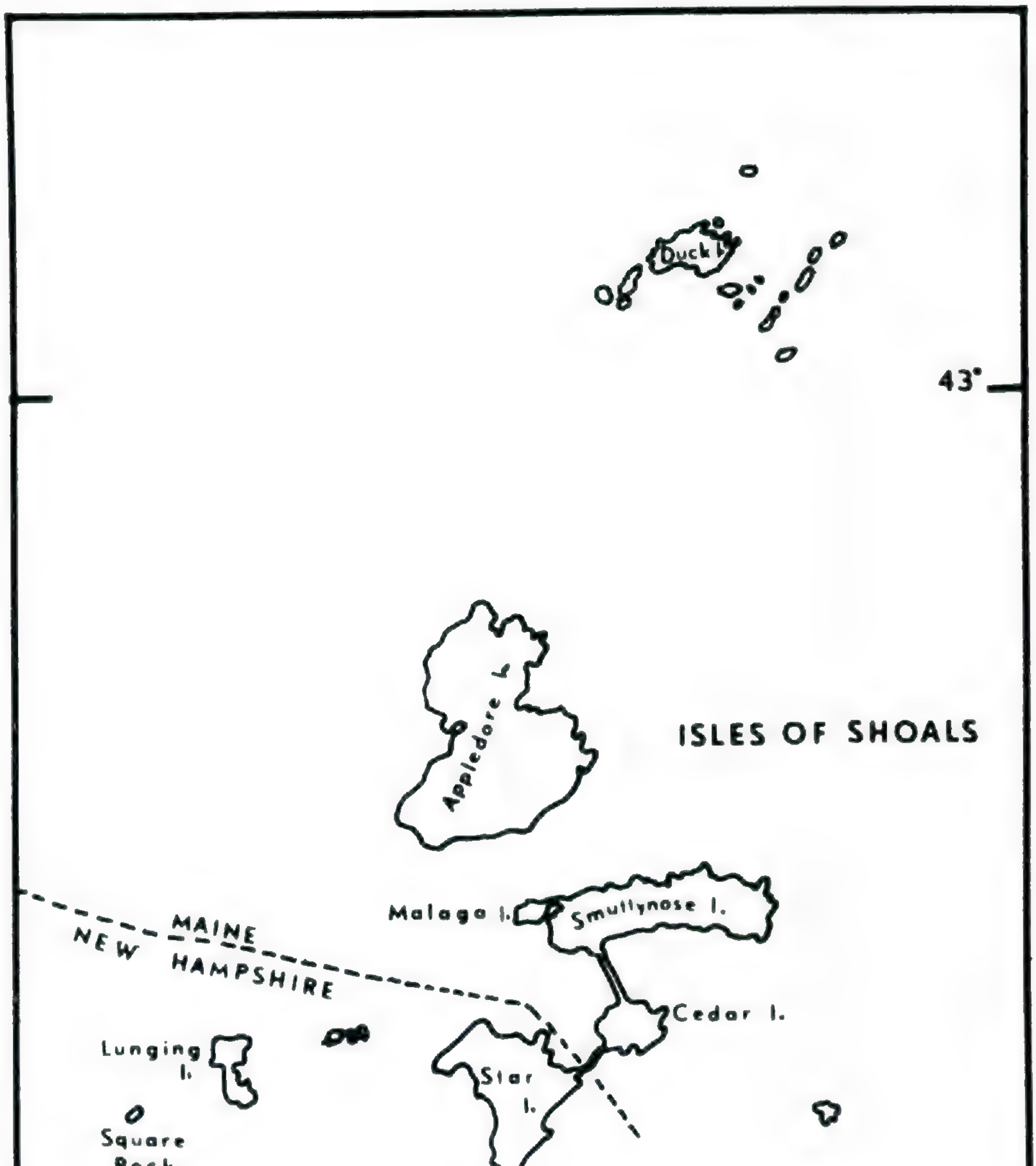

Figure 2

The Isles of Shoals

location (Lewis, 1964). The cobble substrate is probably a major factor determining its vegetation.

Bound Rock (Fig. 1, Station 10) is a sandy beach with massive rock outcrops and breakwaters. Few species are present because of extreme sand fluctuation. Vast beds of *Mytilus* and *Fucus vesiculosus* occur on the rock surfaces. Only a few tidepools are present and they are exposed to constant fluctuations of sand. The breakwaters are dominated by annuals (*Porphyra umbilicalis* and *Bangia fuscopurpurea*).

Isles of Shoals

The Isles of Shoals (Fig. 2) are located approximately 9 miles SSE of the mouth of the Piscataqua River, and 6.5 miles due east of Straw Point, Rye. The Islands occupy an area three miles north-south by 1.5 miles east-west, and lie within the coordinates 42°58′ N, 70°37′20″ W and 43°00′30″ N, 70°36′ W.

There are nine major islands: five belong to the town of Kittery, Maine (Duck, Appledore, Malaga, Smuttynose, Cedar) and four to Rye, N.H. (Star, White, Seavey, Lunging). Nine other rocks and ledges are present in the Island group (Square Rock, Halfway Rocks, Eastern Rocks, Mingo Rock, Shag Rock, Anderson Ledge, Southwest Ledge, Cedar Island Ledge, White Island Ledge).

Great Bay Estuary System

The Great Bay Estuary System includes the Piscataqua River, Little Bay, Great Bay and seven major tributaries (Fig. 1). It is located approximately within the coordinates 43°03′ N — 43°08′ N, 70°45′ W — 70°55′ W. Many tributaries, however, extend beyond these boundaries. A detailed description of the Great Bay Estuary Complex is given by Mathieson, Reynolds, and Hehre (in press).

Table 1 summarizes the seasonal occurrence and reproductive periodicity of the Rhodophyceae in New Hampshire. About 65% of the taxa found on the open coast are perennials (e.g., *Ahnfeltia plicata*, *Petrocelis middendorfii*,

Plumaria elegans, Phycodrys rubens, Polysiphonia lanosa, Phyllophora brodiaei, P. membranifolia, Rhodochorton purpureum, Ptilota serrata, Cystoclonium purpureum var. *cirrhosum, Ceramium rubrum, Corallina officinalis, Halosaccion ramentaceum, Clathromorphum circumscriptum, Hildenbrandia prototypus, Dermatolithon pustulatum, Membranoptera alata, Chondrus crispus, Gigartina stellata, Euthora cristata, Rhodymenia palmata*).

Three distinct types of annuals (winter, spring and summer) are distinguishable according to their season of maximum growth and development. No fall annuals have been found, although many summer plants persist into the fall and early winter. The fall season appears to be a transition period between summer and winter. Most annuals which occur on the open coast grow during the winter and spring (e.g., *Porphyra leucosticta, P. miniata, P. linearis, Bangia fuscopurpurea*). Summer annuals, which may persist into the fall, constitute a small part of the Rhodophycean flora of the Great Bay Estuary System (e.g., *Chondria baileyana, Dasya pedicellata, Lomentaria baileyana, Polysiphonia denudata, P. subtilissima, Ceramium strictum*). Only two summer annuals are restricted to the open coast (*Kylinia alariae* and *Nemalion helminthoides*).

Certain annuals (e.g., *Porphyra umbilicalis*) occur throughout the year and are precociously reproductive.[3] Others (e.g., *Dumontia incrassata*) occurred throughout the year, but reproductive organs were found only in the spring and summer. Many perennials are reproductive throughout the year (e.g., *Ceramium rubrum, Ahnfeltia plicata, Audouinella membranacea, Chondrus crispus, Euthora cristata, Phycodrys rubens, Phyllophora brodiaei, Polysiphonia lanosa, P. novae-angliae, Halosaccion ramentaceum, Rhodymenia palmata, Gigartina stellata, Hildenbrandia proto-*

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[3]Designates a plant that is reproductive throughout the year and that is usually found reproductive.

typus). Others have distinct periods of reproduction which may span one or more seasons (e.g., *Clathromorphum circumscriptum*, *Polyides rotundus*, *Melobesia lejolisii*, *Membranoptera alata*, *Phyllophora membranifolia*, *Cystoclonium purpureum* var. *cirrhosum*, *Plumaria elegans*, *Petrocelis middendorfii*, *Rhodomela confervoides*).

Several species have been collected only on one or two occasions e.g., *Bonnemaisonia hamifera*, *Trailliella intricata*, *Bangia ciliaris*, *Ceramium rubriforme*, *Erythrotrichia carnea*, *Pantoneura baerii*, *Peyssonelia rosenvingii*, *Lomentaria orcadensis*, *Antithamnion plumula*, and *Callithamnion corymbosum* while *Gloiosiphonia capillaris*, *Phyllophora traillii*, *Antithamnion boreale*, *A. pylaisaei*, and *Polysiphonia flexicaulis* were collected once or twice by Dr. Croasdale on the Isles of Shoals during the summer of 1938. Information regarding the seasonal occurrence and reproductive periodicity of these 15 taxa is incomplete.

ANNOTATED CHECKLIST

The following checklist includes 88 taxa of Rhodophyceae from the Great Bay Estuary System and coastal environments of New Hampshire (including the Isles of Shoals). It incorporates all known records of marine red algae from New Hampshire, as well as information on seasonality, reproduction and distribution (vertical and horizontal). Each taxon is cited at least once from every New Hampshire station at which it has been found, even though several collections may have been made. The numbers refer to the collector numbers on the specimens. Fifteen species are new records for the state of New Hampshire (*Porphyra leucosticta*, *P. linearis*, *Acrochaetium polyides*, *Kylinia virgatula*, *Bonnemaisonia hamifera*, *Rhodophysema georgii*, *Antithamnion americanum*, *A. plumula*, *A. pylaisaei*, *Callithamnion corymbosum*, *Pantoneura baerii*, *Chondria baileyana*, *Polysiphonia denudata*, *P. flexicaulis*, *P. subtilissima*), two of which represent extensions of range on the northeast coast of North America (*Acrochaetium polyides* and *Antithamnion plumula*).

BANGIOIDEAE
Bangiales

ERYTHROPELTIDACEAE

Erythrotrichia carnea (Dillwyn) J. Agardh

Found three times (February, September, November), vegetative. Epiphytic on *Ceramium deslongchampsii* var. *hooperi*, *Pylaiella littoralis* and *Polysiphonia lanosa* in the lower eulittoral zone. Found in coastal and estuarine environments; annual.

Recorded from the tropics to Nova Scotia, St. James Bay and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 23 February 1966 (*M*1637); Shaw's Hill, Piscataqua River, 21 September 1966 (*H*967); Cedar Point, 23 November 1966 (*H*968).

Porphyropsis coccinea (J. Agardh *ex* Areschoug) Rosenvinge

Epiphytic on *Desmarestia aculeata*, and probably growing in the deep sublittoral zone. The only New England records for this species are the two specimens collected by F. S. Collins; annual (?).

Recorded from New York, New Hampshire, Nova Scotia and Baie des Chaleurs (as summarized in Taylor, 1957; Edelstein and McLachlan, 1968; Cardinal, 1967).

REPRESENTATIVE SPECIMEN: Hampton Beach, August 1884 (FH, *J. S. Collins*).

BANGIACEAE

Bangia ciliaris Carmichael

Found once, vegetative, epiphytic on *Euthora cristata* in the sublittoral zone on the open coast; annual.

Recorded from South Carolina to Maine, Nova Scotia, and Newfoundland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 10 June 1967 (*H*225).

Bangia fuscopurpurea (Dillwyn) Lyngbye

Found from November to August in the mid to upper eulittoral zone. Common on the open coast, but with restricted distribution in Great Bay Estuary; annual; monospores found from December-April.

Recorded from Bermuda to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (*H*165); Fort Constitution, 29 May 1967 (*H*169); Odiorne's Point, 8 April 1967 (*H*170); North Wallis Sands, 20 March 1967 (*H*172); Concord Point, 5 March 1967 (*H*176); Ragged Neck, 9 March 1967 (*H*178); Rye Ledge, 25 May 1967 (*H*184); Little Boar's Head, 17 February 1967 (*H*185); Great Boar's Head, 24 January 1967 (*H*192); Bound Rock, 18 January 1967 (*H*194); Piscataqua River toll bridge, 29 May 1967 (*H*202); Hilton Park, 24 May 1967 (*H*204).

***Porphyra leucosticta** Thuret in Le Jolis[4]

Found in January, March-July. Epiphytic on *Fucus* spp., *Chondrus crispus*, and *Polysiphonia elongata* in the low eulittoral and sublittoral fringe zones.

Occasional on the open coast and rare in the Estuary. Annual; α spores found in March and April; β spores found March-May.

Recorded from Bermuda to Maine and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 23 July 1958 (*FH I. M. Lamb A*82); Jaffrey Point, 14 April 1968 (*M*5773); Odiorne's Point, 23 May 1968 (*M*2775); Hilton Park, 7 January 1967 (*H*2237).

***Porphyra linearis** Greville

Found from December to May on rocks in the mid eulittoral zone on the open coast. Annual; α spores found April and May; β spores found February and March.

Recorded from Northern Massachusetts, Nova Scotia, Gaspé to Newfoundland (Lamb and Zimmermann, 1964; Edelstein and McLachlan, 1966b; as summarized in Taylor, 1957 as *Porphyra umbilicalis* f. *linearis*).

REPRESENTATIVE SPECIMENS: North Wallis Sands, 16 January 1967 (*H*2239); Concord Point, 19 February 1967 (*H*2240); Ragged Neck, 4 April 1967 (*H*2243); Rye Ledge, 10 January 1967 (*H*2245); Little Boar's Head, 2 April 1967 (*H*2247).

Porphyra miniata (C. Agardh) C. Agardh

Found from March to August on rocks and epiphytic on *Chondrus crispus* in the upper sublittoral zone. Common on the open coast but with limited distribution in the Estu-

[4]*New record for New Hampshire.

ary. Annual; α spores found April to August; β spores found March to August.
Recorded from Northern Massachusetts to the arctic (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (*M*5813); Jaffrey Point, 19 May 1964 (*H*2248); Fort Constitution, 23 June 1967 (*H*2251); Odiorne's Point, 30 May 1967 (*H*2253); North Wallis Sands, 20 May 1967 (*H*2257); Concord Point, 27 June 1967 (*H*2260); Ragged Neck, 14 July 1967 (*M*5826); Rye Ledge, 25 May 1967 (*H*2261); Great Boar's Head, 18 April 1966 (*M*5828); Piscataqua River toll bridge, 29 May 1967 (*H*2263); Hilton Park, 23 June 1967 (*H*2264); Cedar Point, 24 June 1967 (*H*2265).

Porphyra umbilicalis (Linnaeus) J. Agardh

Found throughout the year on rocks in the mid to lower eulittoral zone. Common on the open coast and throughout the Estuary. Annual; α and β spores found January-December.
Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*5861); Jaffrey Point, 7 January 1967 (*H*2268); Fort Constitution, 20 September 1966 (*H*2274); Odiorne's Point, 21 July 1966 (*M*5869); North Wallis Sands, 28 February 1967 (*H*2275); Concord Point, 27 June 1967 (*H*2278); Ragged Neck, 9 March 1967 (*H*2280); Rye Ledge, 25 May 1967 (*H*2288); Little Boar's Head, 24 May 1967 (*H*2292); Great Boar's Head, 24 January 1967 (*H*2294); Bound Rock, 20 February 1967 (*H*2302); Piscataqua River toll bridge, 20 January 1967 (*H*2337); Hilton Park, 9 December 1966 (*H*2326); Cedar Point, 7 August 1967 (*H*2318); Adams Point, 22 December 1966 *H*2314); Weeks Point, 23 April 1966 (*M*5908).

Porphyra umbilicalis (Linnaeus) J. Agardh
forma **epiphytica** Collins

Epiphytic on various algae (e.g., *Fucus* spp. and *Polysiphonia lanosa*) throughout the year in the lower eulittoral and upper sublittoral zones. Common on the open coast and throughout the Estuary. Annual; α spores found January-November; β spores found January-December.
Recorded from Massachusetts to Maine (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5939); Jaffrey Point, 1 April 1967 (*H*2350); Fort Constitution, 22 June 1966 (*M*5944); Odiorne's Point, 30 May 1967 (*H*2355);

North Wallis Sands, 11 June 1967 (*H*2359); Concord Point, 10 August 1967 (*H*2363); Ragged Neck, 12 June 1967 (*H*2367); Rye Ledge, 25 May 1967 (*H*2371); Little Boar's Head, 2 April 1967 (*H*2372); Great Boar's Head, 25 June 1967 (*H*2377); Bound Rock, 18 January 1967 (*H*2383); Piscataqua River toll bridge, 12 August 1967 (*H*2395); Hilton Park, 27 April 1967 (*H*2391); Cedar Point, 23 November 1966 (*H*2398); Durham Point, 15 November 1966 (*H*2396); Adams Point, 27 June 1967 (*H*2400).

FLORIDEAE

NEMALIONALES

ACROCHAETIACEAE

Acrochaetium polyides (Rosenvinge) Børgesen[5]

Found once as an endophyte in the peripheral cells of *Polyides rotundus* on the open coast. This is only the second time that the species has been recorded in North America. No reproductive structures seen; annual (?).

Previously recorded from Nova Scotia (Edelstein and McLachlan, 1966a).

REPRESENTATIVE SPECIMEN: North Wallis Sands, 10 September 1966 (*H*1).

Audouinella membranacea (Magnus) Papenfuss

Endozoic in the lorica of sertularians in the mid to lower eulittoral zone. Common on the open coast, but with limited distribution in the Estuary. Perennial (?); tetraspores found January-December.

Recorded from Connecticut to Maine, Nova Scotia and Greenland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Lund, 1959).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (*H*76); Fort Constitution, 20 January 1967 (*H*78); Odiorne's Point, 21 February 1967 (*H*83); North Wallis Sands, 20 March 1967 (*H*87); Concord Point, 8 January 1967 (*H*93); Ragged Neck, 26 December 1966 (*H*106); Rye Ledge, 25 April 1967 (*H*107); Little Boar's Head, 23 January 1967 (*H*113); Great Boar's Head, 24 January 1967 (*H*122); Bound Rock, 6 December 1966 (*H*129); Piscataqua River toll bridge, 22 June 1967 (*H*164); Hilton Park, 24 May 1967 (*H*153); Cedar Point, 3 March 1967 (*H*146); Durham Point, 26 June 1967 (*H*149); Adams Point, 17 April 1967 (*H*142); Weeks Point, 9 August 1967 (*M*3788).

Kylinia alariae (Jónsson) Kylin

Specific epiphyte on *Alaria esculenta* and restricted to ex-

[5]**Range extension for the northeast coast of North America.

posed coastal stations where *A. esculenta* occurs. Found in the sublittoral fringe zone in July and August. Annual; monospores found in July.

Recorded from Northern Massachusetts to Maine and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*4963); Rye Ledge, 18 August 1966 (*M*4964).

Kylinia secundata (Lyngbye) Papenfuss

Epiphytic on *Ruppia maritima*, various algae (e.g., *Porphyra umbilicalis*) and epizoic on sertularians. Common on the open coast and with limited distribution in the Estuary. Perennial (?); monospores found January-December; tetraspores rare, found once in March.

Recorded from Connecticut to Maine, Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 12 October 1966 (*H*1369); Fort Constitution, 29 May 1967 (*H*135); Odiorne's Point, 21 January 1967 (*H*137); North Wallis Sands, 21 December 1966 (*H*138); Concord Point, 10 December, 1966 (*H*139); Ragged Neck, 18 July 1966 (*M*4966); Rye Ledge, 29 March 1967 (*M*4967); Little Boar's Head, 25 November 1966 (*H*1372); Bound Rock, 7 January 1967 (*H*1373); Piscataqua River toll bridge, 12 August 1967 (*H*160); Hilton Park, 24 May 1967 (*H*153); Cedar Point, 21 December 1966 (*H*145); Durham Point, 19 September 1966 (*H*1374); Adams Point, 22 December 1966 (*H*141).

***Kylinia virgatula** (Harvey) Papenfuss

Epiphytic on specimens of *Rhodymenia palmata*. Found in September, October and December on the open coast. Annual; monospores found in September, October and December.

Previously recorded from North Carolina to Southern Massachusetts, Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Rye Ledge, 15 October 1966 (*H*1375); Little Boar's Head, 14 September 1966 (*H*1376); Great Boar's Head, 14 October 1966 (*H*1377).

Kylinia virgatula (Harvey) Papenfuss

forma **luxurians** (J. Agardh) Collins

Found four times (in July and September). Epiphytic on the margins of *Zostera* leaves. Annual; monospores found in July and September.

Recorded from Connecticut to Maine and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Fort Constitution, 20 September 1966 (*H*1379); Shaw's Hill, Piscataqua River, 21 September 1966 (*H*1380); Shapleigh Island, Piscataqua River, 21 September 1966 (*H*1381); Fox Point, 21 July 1966 (*M*4977).

Rhodochorton purpureum (Lightfoot) Rosenvinge

Growing in the mid and lower eulittoral zone on rock faces covered by fucoids. Common throughout the year on the open coast, but with limited distribution in the Estuary. Perennial; tetraspores found in February.

Recorded from Rhode Island to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Smuttynose Island), 22 July 1966 (*M*6004); Jaffrey Point, 12 October 1966 (*H*2458); Fort Constitution, 28 April 1967 (*M*6008); Odiorne's Point, 21 January 1967 (*H*2469); North Wallis Sands, 20 March 1967 (*H*2479); Concord Point, 5 March 1967 (*H*2490); Ragged Neck, 4 April 1967 (*H*2491); Rye Ledge, 23 December 1966 (*H*2502); Little Boar's Head, 14 August 1967 (*H*2509); Great Boar's Head, 24 January 1967 (*H*2520); Bound Rock, 16 April 1967 (*H*2526); Hilton Park, 9 July 1967 (*H*2528).

BATRACHOSPERMACEAE

Batrachospermum sp.

Collected at the headtide of the Oyster River (Dr. Lewis Flint, personal communication).

Lemanea fucina Bory

Found in rapidly flowing waters at the headtide of the Oyster River (Wood and Straughan, 1953). No specimens were seen from this station. *L. fucina* is found on the University of New Hampshire campus, where the Oyster River is entirely fresh water. There are specimens in the University of New Hampshire Algal Herbarium collected by Dr. A. R. Hodgdon from an estuarine habitat in Maine.

REPRESENTATIVE SPECIMEN: Newcastle, Maine, 29 June 1964 (A. R. Hodgdon 14090).

HELMINTHOCLADIACEAE

Nemalion helminthoides (Velley in Withering) Batters

Found in July and August growing on rocks and mussels *(Mytilus edulis)* in the extreme lower eulittoral zone. Restricted to the open coast. Annual; cystocarpic plants found in August.

Recorded from Long Island to Nova Scotia (as summarized in Taylor, 1957 as *Nemalion multifidum*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5120); Ragged Neck, 10 August 1967 (*H*1598); Rye Ledge, 12 August 1967 (*M*5121); Bound Rock, 18 July 1966 (*H*1599).

BONNEMAISONIACEAE

***Bonnemaisonia hamifera** Hariot

Collected three times (April, June and July) in drift. Vegetative; probably growing in the deep sublittoral zone. Annual (Chihara, 1961).

Previously recorded from Long Island to Southern Massachusetts and Nova Scotia (as summarized in Taylor, 1957 as *Asparagopsis hamifera*; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (Kingsbury, 1965); Isles of Shoals (Cedar Island), 22 July 1966 (*H*75); Isles of Shoals (Smuttynose Island), 16 June 1966 (*M*3765).

Trailliella intricata (J. Agardh) Batters

Found once, vegetative, in the low eulittoral zone on the open coast. It is believed to be the tetrasporophyte of *Bonnemaisonia hamifera* (Chihara, 1961, 1962).

Recorded from Long Island to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Star Island), 22 July 1966 (*M*6076).

CRYPTONEMIALES

SQUAMARIACEAE

Peyssonelia rosenvingii Schmitz in Rosenvinge

Found twice (January and April), vegetative, growing on rocks in the lower eulittoral and sublittoral zones on the open coast. Perennial.

Recorded from Northern Massachusetts to Maine, Nova Scotia, Baie des Chaleurs, Baie de Gaspé and Greenland (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967; Cardinal, 1967; Lund, 1959).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 22 January 1966 (*M*5130); Jaffrey Point, 20 April 1967 (*M*5129).

***Rhodophysema georgii** Batters

Found throughout most of the year as an epiphyte on *Zostera marina*. Perennial; tetraspores found in February and November.

Recorded from Long Island to Maine, Nova Scotia and Newfoundland (as summarized in Taylor, 1957, as *Rhododermis georgii*; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Fort Constitution, 29 May 1967 (*H*2530); Rye Ledge, 11 November 1966 (*H*1056); Cedar Point, 29 May 1967 (*H*2534); Adams Point, 17 April 1967 (*H*2532).

HILDENBRANDIACEAE

Hildenbrandia prototypus Nardo

Growing on rocks throughout the year in the eulittoral and upper sublittoral zones. Common on the open coast and throughout the Estuary. Perennial; tetraspores found January-December.

Recorded from Florida to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*4882); Jaffrey Point, 8 November 1966 (*H*1223); Fort Constitution, 23 June 1967 (*H*1239); Odiorne's Point, 17 October 1966 (*H*1240); North Wallis Sands, 11 June 1967 (*H*1256); Concord Point, 13 September 1966 (*H*1260); Ragged Neck, 9 March 1967 (*H*1271); Rye Ledge, 25 May 1967 (*H*1287); Little Boar's Head, 23 January 1967 (*H*1297); Great Boar's Head, 24 April 1967 (*H*1306); Bound Rock, 6 December 1966 (*H*1314); Piscataqua River toll bridge, 27 February 1967 (*H*1361); Hilton Park, 24 May 1967 (*H*1353); Cedar Point, 17 April 1967 (*H*1325); Durham Point, 31 May 1967 (*H*1336); Adams Point, 17 April 1967 (*H*1319); Fabyan's Point, 15 October 1966 (*H*1339); Pierce Point, 23 June 1967 (*H*1362).

CORALLINACEAE

Clathromorphum circumscriptum (Strømfelt) Foslie

Found throughout the year in tidepools in the mid and lower eulittoral zone, and extending into the sublittoral zone. Common on the open coast and rare in the Estuary. Perennial; bispores found from December-May.

Recorded from Northern Massachusetts to Ellesmere Island

(as summarized in Taylor, 1957, as *Phymatolithon compactum;* Adey, 1965).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*4312); Jaffrey Point, 8 November 1966 (*H*586); Fort Constitution, 21 March 1967 (*H*594); Odiorne's Point, 26 November 1966 (*H*604); North Wallis Sands, 11 October 1966 (*H*619); Concord Point, 13 September 1966 (*H*629); Ragged Neck, 19 February 1967 (*H*641); Rye Ledge, 11 November 1966 (*H*667); Little Boar's Head, 2 April 1967 (*H*649); Great Boar's Head, 24 January 1967 (*H*658); Hilton Park, 24 May 1967 (*H*617).

Corallina officinalis Linnaeus

Growing from the sublittoral zone to the mid eulittoral zone on the open coast. Perennial.

Recorded from Bermuda to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*4363); Jaffrey Point, 7 January 1967 (*H*679); Fort Constitution, 4 December 1966 (*H*684); Odiorne's Point, 26 June 1967 (*H*692); North Wallis Sands, 11 October 1966 (*H*705); Concord Point, 10 August 1967 (*H*713); Ragged Neck, 12 June 1967 (*H*725); Rye Ledge, 11 November 1966 (H741); Little Boar's Head, 13 October 1966 (*H*751); Great Boar's Head, 25 June 1967 (*H*759); Bound Rock, 3 September 1967 (*H*757).

Dermatolithon pustulatum (Lamouroux) Foslie

Found throughout the year as an epiphyte on various algae (e.g., *Chondrus crispus*, *Gigartina stellata*, *Fucus* spp.) in the lower eulittoral and sublittoral fringe zones of the open coast. Perennial; bispores found in all months except April.

Recorded from Rhode Island to Massachusetts, New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Mathieson, Hehre and Reynolds, in press; Edelstein, McLachlan and Craigie, 1967, all as *Lithophyllum macrocarpum*; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*5006); Jaffrey Point, 1 April 1967 (*H*1438); Fort Constitution, 27 February 1967 (H1442); Odiorne's Point, 10 March 1967 (*H*1453); North Wallis Sands, 16 January 1967 (*H*1463); Concord Point, 22 November 1966 (*H*1474); Ragged Neck, 12 June 1967 (*H*1483); Rye Ledge, 25 April 1967 (*H*1494); Little Boar's Head, 13 October 1966 (*H*1497); Great Boar's Head, 24 April 1967 (*H*1504); Bound Rock, 6 December 1966 (*H*1518); Hilton Park, 17 February 1968 (*M*5039).

Lithophyllum corallinae (Crouan frat.) Heydrich
Specific epiphyte on *Corallina officinalis* on the open coast. Perennial; bispores found in March, June and July.
Recorded from Rhode Island to Maine (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Cedar Island), 22 July 1966 (*H*1379); Jaffrey Point, 7 January 1967 (*H*1384); Fort Constitution, 22 June 1966 (*M*4993); Odiorne's Point, 10 March 1967 (*H*1393); North Wallis Sands, 20 May 1967 (*H*1397); Concord Point, 5 March 1967 (*H*1404); Ragged Neck, 9 March 1967 (*H*1410); Rye Ledge, 11 November 1966 (*H*1417); Little Boar's Head, 8 March 1967 (*H*1426); Great Boar's Head, 20 March 1967 (*H*1432).

Lithothamnium glaciale Kjellman
Growing in the lower eulittoral and sublittoral zones on the open coast. Perennial; bispores found in February and April.
Recorded from Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Jaffrey Point, 1 April 1967 (*H*1550); Fort Constitution, 21 March 1967 (*H*1536); Odiorne's Point, 10 March 1967 (*H*1542); North Wallis Sands, 20 March 1967 (*H*1538); Concord Point, 27 June 1967 (*H*1524); Rye Ledge, 22 June 1967 (*H*1519); Little Boar's Head, 27 July 1967 (*H*1528); Great Boar's Head, 24 April 1967 (*H*1522); Bound Rock, 18 November 1966 (*H*1523).

Melobesia lejolisii Rosanoff
Found throughout the year as an epiphyte on *Zostera* and *Phyllophora* spp. in the sublittoral zone. Common in drift on the open coast and throughout the Estuary. Perennial; tetraspores found October-July.
Recorded from Florida to the arctic (as summarized in Taylor, 1957, as *Fosliella lejolisii*).
REPRESENTATIVE SPECIMENS: Jaffrey Point, 23 February 1966 (*M*4710); Fort Constitution, 21 March 1967 (*H*1040); Odiorne's Point, 8 April 1967 (*H*1044); North Wallis Sands, 17 April 1967 (*H*1051); Concord Point, 27 June 1967 (*H*1052); Ragged Neck, 9 March 1967 (*H*1054); Rye Ledge, 15 October 1966 (*H*1057); Little Boar's Head, 25 November 1966 (*H*1058); Hilton Park, 3 May 1968 (*M*4712); Durham Point, 16 October 1966 (*H*1059); Pierce Point, 8 November 1966 (*H*1060).

Phymatolithon lenormandi (Areschoug) Adey
Growing on rocks and shells throughout most of the year

in the sublittoral zone on the open coast, but with restricted distribution in the Estuary. No reproductive structures found; perennial.

Recorded from New Jersey to the arctic (as summarized in Taylor, 1957, as *Lithothamnium lenormandi*; Adey, 1966).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Smuttynose Island), 22 July 1966 (*M*5312); Jaffrey Point, 6 May 1967 (*M*5311); Fort Constitution, 28 April 1968 (*M*5313); Odiorne's Point, 17 October 1966 (*H*1890); North Wallis Sands, 16 February 1967 (*M*5315); Concord Point, 9 October 1966 (*H*1891); Ragged Neck, 8 October 1966 (*H*1892); Rye Ledge, 15 October 1966 (*H*1895); Little Boar's Head, 13 October 1966 (*H*1896); Great Boar's Head, 14 October 1966 (*H*1898); Hilton Park, 14 October 1966 (*H*1899).

DUMONTIACEAE

Dumontia incrassata (O. F. Müller) Lamouroux

Common in the mid to lower eulittoral zone throughout the year on the open coast, and with limited distribution in the Estuary. Often found in tidepools; annual, tetraspores found March-August.

Recorded from Long Island to Nova Scotia and James Bay (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*4604); Jaffrey Point, 7 January 1967 (*H*939); Fort Constitution, 20 January 1967 (*H*948); Odiorne's Point, 8 April 1967 (*H*954); North Wallis Sands, 20 March 1967 (*H*960); Concord Point, 5 March 1967 (*H*904); Ragged Neck, 22 May 1967 (*H*910); Rye Ledge, 25 May 1967 (*H*913); Little Boar's Head, 23 January 1967 (*H*920); Great Boar's Head, 24 April 1967 (*H*935); Bound Rock, 6 December 1966 (*H*938); Piscataqua River toll bridge, 4 December 1966 (*H*881); Hilton Park, 14 October 1966 (*H*870); Cedar Point, 3 March 1967 (*H*892); Fox Point, 17 November 1966 (*H*896); Nannie Island, 7 July 1966 (*M*4578).

POLYIDEACEAE

Polyides rotundus (Hudson) Greville

Growing in the sublittoral zone throughout the year on the open coast and with limited distribution in the Estuary. Perennial; tetraspores found from October to January; cystocarpic nemathecia found from October to February.

Recorded from Long Island to the Hudson Strait (as summarized in Taylor, 1957, as *Polyides caprinus*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (*M*5363); Jaffrey Point, 7 January 1967 (*H*1915); Fort Constitution, 24 July 1967 (*M*5378); Odiorne's Point, 26 July 1967 (*H*1917); North Wallis Sands, 11 October 1966 (*H*1920); Concord Point, 8 January 1967 (*H*1925); Ragged Neck, 9 March 1967 (*H*1927); Rye Ledge, 15 October 1966 (*H*1928); Little Boar's Head, 24 May 1967 (*H*1931); Great Boar's Head, 13 November 1966 (*H*1938); Bound Rock, 18 January 1967 (*M*1945); Piscataqua River toll bridge, 27 February 1967 (*H*1948); Hilton Park, 27 April 1967 (*H*1947).

GLOIOSIPHONIACEAE

Gloiosiphonia capillaris (Hudson) Carmichael *ex* Berkeley
Found once by Croasdale (July) growing on the open coast.
Annual; cystocarpic in July.
Recorded from Connecticut to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 25 July 1938 (*Croasdale* 4794).

KALLYMENIACEAE

Euthora cristata (C. Agardh) J. Agardh
Growing in the sublittoral zone on the open coast throughout the year. Perennial; tetrasporic and cystocarpic plants found from January to December.
Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*4660); Jaffrey Point, 1 April 1967 (*H*969); Fort Constitution, 27 February 1967 (*H*974); Odiorne's Point, 30 May 1967 (*H*977); North Wallis Sands, 20 May 1967 (*H*985); Concord Point, 10 December 1966 (*H*992); Ragged Neck, 9 March 1967 (*H*1004); Rye Ledge, 10 January 1967 (*H*1016); Little Boar's Head, 24 May 1967 (*H*1023); Great Boar's Head, 25 June 1967 (*H*1028); Bound Rock, 6 December 1966 (*H*1029).

CHOREOCOLACACEAE

Choreocolax polysiphoniae Reinsch
Parasitic on the fronds of *Polysiphonia lanosa*. Restricted to the open coast. Present throughout the year and perennial; tetraspores found from January to December; cystocarpic plants found in July, August and November.
Recorded from Connecticut to Nova Scotia and Newfound-

land (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 10 June 1967 (*H*551); Fort Constitution, 23 June 1967 (*H*554); Odiorne's Point, 11 August 1967 (*H*561); North Wallis Sands, 17 April 1967 (*H*562); Concord Point, 21 May 1967 (*H*567); Ragged Neck, 22 May 1967 (*H*571); Rye Ledge, 25 May 1967 (*H*575); Little Boar's Head, 14 August 1967 (*H*580); Great Boar's Head, 24 April 1967 (*H*584).

GIGARTINALES

CRUORIACEAE

Petrocelis middendorfii (Ruprecht) Kjellman

Found throughout the year on rocks in the lower eulittoral zone. Common on the open coast and with restricted distribution in the Estuary. Perennial; tetraspores found from October to June.

Recorded from Long Island to Maine, Nova Scotia and the Arctic (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5135); Jaffrey Point, 5 December 1966 (*H*1604); Fort Constitution, 21 March 1967 (*H*1607); Odiorne's Point, 30 May 1967 (*H*1617); North Wallis Sands, 11 June 1967 (*H*1626); Concord Point, 3 April 1967 (*H*1634); Ragged Neck, 20 July 1967 (*H*1640); Rye Ledge, 24 July 1967 (*H*1649); Little Boar's Head, 24 May 1967 (*H*1663); Great Boar's Head, 25 June 1967 (*H*1670); Hilton Park, 24 May 1967 (*H*1665).

SOLIERIACEAE

Agardhiella tenera (J. Agardh) Schmitz

Reported by Taylor (1957) from N.H. However, none of the herbarium specimens nor references cited by Taylor indicate that it is found north of Gloucester, Massachusetts.

Recorded from the tropics to North Carolina, north to Massachusetts and New Hampshire (as summarized in Taylor, 1957).

RHODOPHYLLIDACEAE

Cystoclonium purpureum (Hudson) Batters
var. **cirrhosum** Harvey

Found throughout the year growing on rocks and occasionally on other algae in the lower eulittoral and sublittoral

zones. Common on the open coast, and with restricted distribution in the Estuary. Perennial; tetraspores found from April to November.

Recorded from New Jersey to New Hampshire, Baie des Chaleurs and Baie de Gaspe (as summarized in Taylor, 1957; Lamb and Zimmermann, 1964; Mathieson, Hehre and Reynolds, in press; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*4441); Jaffrey Point, 7 January 1967 (*H*772); Fort Constitution, 20 September 1966 (*H*780); Odiorne's Point, 11 August 1967 (*H*781); North Wallis Sands, 20 May 1967 (*H*784); Concord Point, 13 September 1966 (*H*792); Ragged Neck, 22 May 1967 (*H*799); Rye Ledge, 15 October 1966 (*H*809); Little Boar's Head, 24 May 1967 (*H*820); Great Boar's Head, 15 September 1966 (*H*822); Bound Rock, 18 November 1966 (*H*829); Piscataqua River toll bridge, 27 February 1967 (*H*858); Hilton Park, 27 April 1967 (*H*847); Durham Point, 15 November 1966 (*H*842); Adams Point, 22 December 1966 (H840).

Rhodophyllis dichotoma (Lepeschkin) Gobi

Found January-February and May-July on the open coast. The plant has been found only 4 times in drift. It was collected once by SCUBA in the deep sublittoral-epiphytic on *Ptilota serrata*. Perennial; tetraspores found in January and July; cystocarpic plants found in February, May and June.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 28 May 1968 (*M*6138); Hampton Beach, 27 February 1966 (*H*2559); Bound Rock, 24 June 1967 (*H*2560).

GRACILARIACEAE

Gracilaria foliifera (Forsskål) Børgesen

Found from March to December either free-floating or attached to small stones in the lower eulittoral and upper sublittoral zones throughout the Estuary. Perennial; tetraspores found from June-October; cystocarpic plants found in April and from June to November.

Recorded from the tropics to New Hampshire (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Hilton Park, 24 May 1967 (*H*1205); Cedar Point, 7 August 1967 (*H*1193); Durham Point, 5 July 1966

(*M*4813); Adams Point, 10 September 1966 (*H*1192); Fabyan's 4813); 23 June 1967 (H1200); Pierce Point, 23 June 1967 (H1207).

PHYLLOPHORACEAE

Ahnfeltia plicata (Hudson) Fries

Growing throughout the year in the lower eulittoral and sublittoral zones on the open coast. Restricted distribution in the Estuary. Perennial; monospores found January-December.

Recorded from New Jersey to Devon Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*3669); Jaffrey Point, 27 May 1967 (*H*2); Fort Constitution, 24 July 1967 (*M*3683); Odiorne's Point, 21 February 1967 (*H*6); North Wallis Sands, 28 February 1967 (*H*14); Concord Point, 8 January 1967 (*H*23); Ragged Neck, 9 March 1967 (*H*25); Rye Ledge, 11 November 1966 (*H*29); Little Boar's Head, 17 February 1967 (*H*38); Great Boar's Head, 24 April 1967 (*H*45); Bound Rock, 17 March 1968 (*H*48); Hilton Park, 9 July 1967 (*H*60); Durham Point, 5 July 1966 (*M*3705); Adams Point, 19 July 1966 (*M*3704); Weeks Point, 14 September 1966 (*H*63).

Ceratocolax hartzii Rosenvinge

Specific parasite on *Phyllophora brodiaei* in the sublittoral zone on the open coast. Perennial; tetraspores found in January, February, April and May.

Recorded from Rhode Island to the Arctic (Newroth, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Cedar Island), 22 July 1966 (*H*369); Jaffrey Point, 8 November 1966 (*H*370); Odiorne's Point, 10 March 1967 (*H*371); North Wallis Sands, 21 December 1966 (*H*372); Ragged Neck, 4 April 1967 (*H*374); Little Boar's Head, 19 February 1966 (*M*4112); Bound Rock, 18 January 1967 (*H*375).

Phyllophora brodiaei (Turner) Endlich

Found throughout the year growing in the sublittoral zone on the open coast. Common in drift. Perennial; carpotetrasporangial nemathecia found from January to December.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*5253); Jaffrey Point, 8 February 1967 (*H*1780); Fort Constitution, 24 July 1967 (*M*5265); Odiorne's Point, 10 September 1966 (*H*1789); North Wallis Sands, 16 January 1967 (*H*1795); Concord Point, 3 April 1967 (*H*1804); Ragged Neck, 23 November

1966 (*H*1805); Rye Ledge, 25 November 1966 (*H*1814); Little Boar's Head, 8 March 1967 (*H*1818); Great Boar's Head, 13 November 1966 (*H*1819); Bound Rock, 6 December 1966 (*H*1824).

Phyllophora membranifolia (Goodenough *et* Woodward) J. Agardh

Growing throughout the year in the lower eulittoral and sublittoral zones on the open coast, and with limited distribution in the Estuary. Perennial; tetraspores found from September to March; cystocarpic plants found in January, March, April and November.

Recorded from New Jersey to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5278); Jaffrey Point, 11 July 1967 (*H*1827); Fort Constitution, 20 September 1966 (*H*1832); Odiorne's Point, 26 June 1967 (*H*1836); North Wallis Sands, 20 May 1967 (*H*1844); Concord Point, 9 October 1966 (*H*1854); Ragged Neck, 10 August 1967 (*H*1861); Rye Ledge, 11 November 1966 (*H*1864); Little Boar's Head, 14 August 1967 (*H*1875); Great Boar's Head, 24 January 1967 (*H*1881); Bound Rock, 18 November 1966 (*H*1886); Hilton Park, 2 October 1968 (*N. B. Reynolds* 286).

Phyllophora traillii Holmes *ex* Batters

Found once by Croasdale in July growing on rocks in the low eulittoral zone on the open coast. Vegetative; perennial.

Recorded from Connecticut to Maine and Nova Scotia (as summarized in Taylor, 1957; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 28 July 1938 (Croasdale 5297).

GIGARTINACEAE

Chondrus crispus Stackhouse

Common throughout the year on rocks and in tidepools in the mid to lower eulittoral zone, and extending into the sublittoral zone. Found on the open coast and throughout most of the Estuary. Perennial; tetraspores found January-December; carpospores found January-May, July, September-November.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*4180); Jaffrey Point, 5 December 1966 (*H*392); Fort Consti-

tution, 20 January 1967 (*H*397); Odiorne's Point, 30 May 1967 (*H*412); North Wallis Sands, (16 January 1967 (*H*418); Concord Point, 9 October 1966 (*H*436); Ragged Neck, 12 June 1967 (*H*445); Rye Ledge, 11 November 1966 (*H*451); Little Boar's Head, 8 March 1967 (*H*463); Great Boar's Head, 24 April 1967 (*H*474); Bound Rock, 6 December 1966 (*H*491); Piscataqua River toll bridge, 27 February 1967 (*H*535); Hilton Park, 14 October 1966 (*H*519); Cedar Point, 15 January 1967 (*H*499); Durham Point, 31 May 1967 (H509); Adams Point, 30 May 1967 (*H*493); Weeks Point, 14 September 1966 (*H*539).

Gigartina stellata (Stackhouse) Batters

Found throughout the year in the lower eulittoral and sublittoral fringe zones on the open coast, and with limited distribution in the Estuary. Perennial; cystocarpic plants found January-December.

Recorded from Rhode Island to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*4741); Jaffrey Point, 5 December 1966 (*H*1062); Fort Constitution, 8 November 1966 (*H*1077); Odiorne's Point, 26 June 1967 (*H*1089); North Wallis Sands, 11 June 1967 (*H*1099); Concord Point, 19 February 1967 (*H*1108); Ragged Neck, 26 December 1966 (*H*1119); Rye Ledge, 22 June 1967 (*H*1129); Little Boar's Head, 14 September 1966 (*H*1141); Great Boar's Head, 14 October 1966 (*H*1152); Bound Rock, 8 August 1967 (*M*4774); Piscataqua River toll bridge, 27 February 1967 (*H*1184); Hilton Park, 24 May 1967 (*H*1162); Cedar Point, 3 March 1967 (*H*1170); Durham Point, 19 September 1966 (*H*1171).

RHODYMENIALES

RHODYMENIACEAE

Halosaccion ramentaceum (Linnaeus) J. Agardh

Growing throughout the year in the sublittoral fringe region. Only found at three coastal stations. Perennial; tetraspores found December-October.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 25 July 1938 (*Croasdale* 4867); Jaffrey Point, 12 October 1966 (*H*1218); Rye Ledge, 26 February 1967 (*H*1221).

Rhodymenia palmata (Linnaeus) Greville

Growing throughout the year in the lower eulittoral and sublittoral zones. Common on the open coast and the Estuary. Perennial; tetraspores found from January to December.

Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (*M*6176); Jaffrey Point, 7 January 1967 (*H*2565); Fort Constitution, 20 September 1966 (*H*2566); Odiorne's Point, 21 February 1967 (*H*2575); North Wallis Sands, 20 March 1967 (*H*2584); Concord Point, 8 January 1967 (*H*2595); Ragged Neck, 10 August 1967 (*H*2600); Rye Ledge, 25 April 1967 (*H*2615); Little Boar's Head, 14 August 1967 (*H*2627); Great Boar's Head, 11 December 1966 (*H*2631); Bound Rock, 18 November 1966 (*H*2641); Piscataqua River toll bridge, 18 October 1966 (*H*2685); Hilton Park, 9 July 1967 (*H*2650); Cedar Point, 24 June 1967 (*H*2671); Durham Point, 14 August 1967 (*H*2672); Adams Point, 22 December 1966 (*H*2666); Pierce Point, 8 November 1966 (*H*2679).

CHAMPIACEAE

Lomentaria baileyana (Harvey) Farlow

Growing on shells, pebbles, epiphytic on other algae or on *Zostera*, or free-floating. Found from July to November; common throughout the Estuary. Annual; tetraspores found in July and August.

Recorded from the tropics to New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Doty and Newhouse, 1954; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Cedar Point, 12 September 1966 (H1557); Durham Point, 19 September 1966 (*H*1558); Adams Point, 13 September 1966 (*H*1563); Fabyan's Point, 17 September 1966 (*H*1565); Pierce Point, 13 September 1966 (*H*1566).

Lomentaria orcadensis (Harvey) Collins *ex* Taylor

Collected in the sublittoral zone (August and October) at two coastal and one estuarine location. Perennial; tetraspores found in August.

Recorded from Rhode Island to Maine (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 August 1967 (*M*5085); Odiorne's Point, 7 August 1967 (*M*5086); Hilton Park, 2 October 1968 (N. B. Reynolds 287).

CERAMIALES

CERAMIACEAE

***Antithamnion americanum** (Harvey) Farlow

Two specimens seen from the open coast; vegetative; annual(?).

Recorded from New Jersey to Labrador (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals, before 1870; (*FH L. L. Thaxter* 7782). Isles of Shoals (*FH Cole*).

Antithamnion boreale (Gobi) Kjellman

Found once by Croasdale (July) growing in the sublittoral zone on the open coast. Annual(?); tetraspores found in July.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 26 July 1938 (*Croasdale* 3728).

Antithamnion cruciatum (C. Agardh) Nägeli

Growing in mud or epiphytic on other algae in the lower eulittoral and sublittoral zones from May to November. Found on the open coast and throughout most of the Estuary. Annual; tetraspores found from June to September. Recorded from Bermuda to New Hampshire and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 26 July 1938 (*Croasdale* 3729); Odiorne's Point, 7 August 1967 (*M*3731); Hilton Park, 9 July 1967 (*H*70); Cedar Point, 12 September 1966 (*H*69); Adams Point, 13 October 1966 (*H*68).

Antithamnion floccosum (O. F. Müller) Kleen

Growing in the sublittoral zone. Found on the open coast, and with restricted distribution in the Estuary. Collected from January to May, and August. Annual; tetraspores found in April and August.

Recorded from Northern Massachusetts to Ile St. Pierre (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (*H*73); Odiorne's Point, 7 August 1967 (*M*3752); Rye Ledge, 20 April 1952 (*M*3753); Adams Point, 4 May 1968 (*M*3754).

****Antithamnion plumula** (Ellis) Thuret in Le Jolis
Found once (July) growing on mud in the low eulittoral zone in the Estuary. No reproductive structures seen; annual.
Previously recorded from New Jersey to Southern Massachusetts (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMEN: Cedar Point, 27 July 1966 (*H*74).

***Antithamnion pylaisaei** (Montagne) Kjellman
Growing in the sublittoral zone on the open coast. Two specimens seen (May); vegetative; annual(?).
Recorded from Long Island to Baffin Island (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 25 May 1938 (*Croasdale* 3762); Rye Beach, (*FH Cole*).

Callithamnion baileyi Harvey
Found throughout most of the year on mud, stones and epiphytic on other algae in the lower eulittoral zone. Present on the open coast and throughout the Estuary. Perennial(?); tetraspores found in March and July; carpospores found from July to October; spermatia found in July, September and October.
Recorded from New Jersey to Prince Edward Island and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).
REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 26 July 1938 (*Croasdale* 3825); Jaffrey Point, 3 May 1968 (*M*3826); Concord Point, 22 November 1966 (*H*210); Piscataqua River toll bridge, 12 August 1967 (*H*214); Hilton Park, 7 January 1967 (*H*218); Cedar Point, 3 March 1967 (*H*213); Durham Point, 16 October 1966 (*H*216); Adams Point, 19 July 1966 (*M*3827); Pierce Point, 25 July 1967 (*H*215).

***Callithamnion corymbosum** (J. E. Smith) Lyngbye
Found in July in the lower eulittoral zone in the Estuary. Annual(?); tetraspores found in July.
Recorded from Bermuda to Nova Scotia (as summarized in Taylor, 1957).
REPRESENTATIVE SPECIMEN: Adams Point, 23 July 1967 *H*219).

Callithamnion roseum (Roth) Lyngbye
Growing on the open coast. One specimen seen; vegetative; annual(?).

Recorded from New Jersey to Southern Massachusetts and New Hampshire (as summarized in Taylor, 1957; Doty and Newhouse, 1954).

REPRESENTATIVE SPECIMEN: Isles of Shoals, before 1870 (FH L. L. *Thaxter* 7788).

Callithamnion tetragonum (Withering) S. F. Gray

Reported by Croasdale (1941) from the Isles of Shoals. No specimens seen; annual(?).

Recorded from New Jersey to Maine (as summarized in Taylor, 1957).

Ceramium deslongchampsii Chauvin in Duby
var. **hooperi** (Harvey) Taylor

Found from April to November growing on rocks and pilings under over-hanging fucoids in the mid to lower eulittoral zone on the open coast and in the Estuary. Perennial(?); tetraspores found in August.

Recorded from Connecticut to the Lower St. Lawrence (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 9 September 1967 (*H*220); North Wallis Sands, 16 July 1967 (*H*221); Piscataqua River toll bridge, 12 August 1967 (*H*222); Cedar Point, 23 November 1966 (*H*223); Squamscott River, 13 September 1966 (*H*224).

Ceramium diaphanum (Lightfoot) Roth

Reported by Collins (1900) and Doty and Newhouse (1954). No specimens seen. The abundance and distribution of this plant given in the latter paper suggests possible confusion with *Ceramium strictum*.

Recorded from Virginia to Prince Edward Island (as summarized in Taylor, 1957).

Ceramium rubriforme Kylin prox.

Found once (July) in the lower eulittoral zone on the open coast. Vegetative; perennial.

Recorded from Southern Massachusetts to New Hampshire and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Star Island), 22 July 1966 (*M*3905).

Ceramium rubrum (Hudson) C. Agardh

Found throughout the year growing on rocks and epiphytic

on various algae in the lower eulittoral and sublittoral zones. Common on the open coast and throughout the Estuary. Perennial; tetraspores found January-December; cystocarpic plants found all months except May.
Recorded from the tropics to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*3940); Jaffrey Point, 7 January 1967 (*H*226); Fort Constitution, 20 September 1966 (*H*234); Odiorne's Point, 21 February 1967 (*H*236); North Wallis Sands, 16 January 1967 (*H*243); Concord Point, 8 January 1967 (*H*253); Ragged Neck, 26 December 1966 (*H*264); Rye Ledge, 11 November 1966 (*H*271); Little Boar's Head, 24 May 1967 (*H*285); Great Boar's Head, 24 January 1967 (*H*288); Bound Rock, 18 January 1967 (*H*299); Piscataqua River toll bridge, 27 February 1967 (*H*349); Hilton Park, 27 April 1967 (*H*339); Cedar Point, 3 March 1967 (*H*317); Durham Point, 26 June 1967 (*H*324); Adams Point, 13 September 1966 (*H*309); Fabyans Point, 8 July 1967 (*H*330); Pierce Point, 23 June 1967 (*H*346); Squamscott River, 4 March 1967 (*H*356).

Ceramium strictum Harvey

Found from June to October growing on rocks and epiphytic on *Zostera* and certain algae. Common throughout the Estuary in the lower eulittoral and sublittoral zones. Rare on the coast. Annual; tetraspores and carpospores found from June to October.
Recorded from Florida to Prince Edward Island and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Concord Point, 13 September 1966 (*H*357); Bound Rock, 19 July 1966 (*M*4079); Hilton Park, 9 July 1967 (*H*358); Cedar Point, 7 August 1967 (*H*362); Durham Point, 14 August 1967 (*H*363); Adams Point, 23 July 1967 (*H*360); Fabyans Point, 2 August 1966 (*M*4100); Squamscott River, 20 July 1966 (*H*366).

Plumaria elegans (Bonnemaison) Schmitz

Found throughout the year growing on vertical rock faces under over-hanging fucoids in the lower eulittoral zone on the open coast. Perennial; paraspores found from September to January.
Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 July 1938 (*Croasdale* 5338); Jaffrey Point, 8 November 1966 (*H*1900); North Wallis Sands, 11 October 1966 (*H*1910); Rye Ledge, 11 November 1966 (*H*1911); Great Boar's Head, 12 August 1967 (*H*1913); Bound Rock, 15 March 1968 (*M*5343).

Ptilota serrata Kützing

Found throughout the year growing in the sublittoral zone on the open coast. Common in drift. Perennial; tetraspores found from November to June; spermatia found in February and March; only one cystocarpic plant found (May). Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island); 28 May 1968 (*M*5984); Jaffrey Point, 6 May, 1967 (*M*5987); Odiorne's Point, 21 February 1967 (*H*2401); North Wallis Sands, 16 January 1967 (*H*2406); Concord Point, 10 December 1966 (*H*2420); Ragged Neck, 9 March 1967 (*H*2422); Rye Ledge, 25 April 1967 (*H*2430); Little Boar's Head, 14 September 1966 (*H*2443); Great Boar's Head, 24 January 1967 (*H*2448); Bound Rock, 18 November 1966 (*H*2453).

Spermothamnion repens (Dillwyn) Rosenvinge

Growing on mud and pebbles in the lower eulittoral zone in March and July-September. Rare on the open coast, and with limited distribution in the Estuary. Perennial; tetraspores found in July.

Recorded from Florida to Nova Scotia (as summarized in Taylor, 1957, as *Spermothamnion turneri*).

REPRESENTATIVE SPECIMENS: North Wallis Sands, 20 March 1967 (*H*245); Cedar Point, 27 July 1966 (*H*2556); Durham Point, 19 September 1966 (*H*2557); Adams Point, 19 July 1966 (*M*6043).

DELESSERIACEAE

Membranoptera alata (Hudson) Stackhouse

Found throughout the year epiphytic on various algae in the sublittoral zone. Frequent in drift on the open coast. Perennial; tetraspores found from November to July.

Recorded from Northern Massachusetts to Baffin Island (as summarized in Taylor, 1957; including *Membranoptera denticulata*. See Mathieson, Hehre and Reynolds, in press).

REPRESENTATIVE SPECIMENS: Isles of Shoals, before 1870 (FH *L. L. Thaxter* 7792); Jaffrey Point, 8 November 1966 (*H*1567); Fort Constitution, 22 June 1966 (*M*5103); Odiorne's Point, 26 July 1967 (*H*1570); North Wallis Sands, 11 June 1967 (*H*1575); Concord Point,

13 September 1966 (*H*1578); Ragged Neck, 18 September 1966 (*H*1580); Rye Ledge, 15 October 1966 (*H*1587); Little Boar's Head, 2 April 1967 (*H*1592); Great Boar's Head, 13 November 1966 (*H*1593); Bound Rock, 18 January 1967 (*H*1596).

***Pantoneura baerii** (Postels *et* Ruprecht) Kylin

Collected twice (May and June) in the sublittoral zone on the open coast. Perennial; tetraspores found in May.

Previously recorded from Northern Massachusetts, Labrador, Hudson Straits and Ellesmere Island (as summarized in Taylor, 1957; Lamb and Zimmermann, 1964).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (*Kingsbury*, 1965); Isles of Shoals (Appledore Island), 28 May 1968 (*M*5118).

Phycodrys rubens (Linnaeus) Batters

Growing throughout the year in the sublittoral zone of the open coast. Young plants occasionally found in deep tide-pools in the lower eulittoral zone. Perennial; tetraspores found October-July; cystocarpic plants found November-August; spermatia found once in July.

Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*5174); Jaffrey Point, 7 January 1967 (*H*1676); Fort Constitution, 23 June 1967 (*H*1685); Odiorne's Point, 21 February 1967 (*H*1689); North Wallis Sands, 11 October 1966 (*H*1696); Concord Point, 13 September 1966 (*H*1713); Ragged Neck, 12 June 1967 (*H*1727); Rye Ledge, 23 December 1966 (*H*1728); Little Boar's Head, 24 May 1967 (*H*1742); Great Boar's Head, 15 September 1966 (*H*1752); Bound Rock, 31 May 1967 (*H*1761).

DASYACEAE

Dasya pedicellata (C. Agardh) C. Agardh

Young plants grow epiphytically on various algae, while older plants occur free-floating or entangled amongst other plants. Common throughout the Estuary from July to December. Annual; tetraspores found from July-October; spermatia and carpospores found from July to November.

Recorded from the tropics to New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Doty and Newhouse, 1954; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Hilton Park, 19 July 1966 (*M*4539); Cedar Point, 7 August 1967 (*H*864); Durham Point, 19 September

1966 (*H*865); Adams Point, 13 October 1966 (*H*862); Fabyans Point, 2 August 1966 (*M*4535); Pierce Point, 18 October 1966 (*H*868).

RHODOMELACEAE

Bostrychia rivularis Harvey

Reported by Farlow (1882). Supposedly found in the vicinity of the Isles of Shoals by Captain Pike. No specimens have been found to verify this species and it remains a doubtful record.

Recorded from the tropics to New Hampshire (as summarized in Taylor, 1957).

***Chondria baileyana** (Montagne) Harvey

Found from June-November, growing on shells, pebbles and epiphytic on other algae and on *Zostera*. It occurs in the lower eulittoral and sublittoral zones throughout the Estuary. Annual; tetraspores found from June to September; cystocarpic plants found in June and September.

Previously recorded from New Jersey to Northern Masschusetts and Nova Scotia (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Durham Point, 14 August 1967 (*H*377); Adams Point, 23 July 1967 (*H*376); Fabyans Point, 17 September 1966 (*H*386); Pierce Point, 13 September 1966 (*H*381).

Chondria tenuissima (Goodenough *et* Woodward) C. Agardh

Reported by Doty and Newhouse (1954). No specimens were available, but from their data, it would appear to be *Chondria baileyana*.

***Polysiphonia denudata** (Dillwyn) Greville *ex* Harvey in Hooker

Found from July to December in the lower eulittoral and sublittoral zones throughout the Estuary. Annual; tetraspores found from July to October; cystocarpic plants found from July to September.

Recorded from the tropics to Prince Edward Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Hilton Park, 28 August 1968 (*N. B. Reynolds* 281); Cedar Point, 12 September 1966 (*H*1952); Durham Point, 19 September 1966 (*H*1953); Adams Point, 13 October 1966 (*H*1950); Fabyans Point, 17 September 1966 (*H*1955); Pierce Point,

8 November 1966 (*H*1958); Squamscott River, 13 September 1966 (*H*1960).

Polysiphonia elongata (Hudson) Sprengel

Found throughout the year growing in tidepools in the lower eulittoral and sublittoral zones throughout the Estuary. Perennial; tetraspores found from June to September; carpospores and spermatia found in July.

Recorded from New York to Prince Edward Island and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Pierce Island, Piscataqua River, 18 July 1966 (*M*5436); Hilton Park, 9 December 1966 (*H*1977); Cedar Point, 23 November 1966 (*H*1983); Durham Point, 15 November 1966 (*H*1988); Adams Point, 13 September 1966 (*H*1968); Fabyans Point, 15 October 1966 (*H*1991); Pierce Point, 8 November 1966 (*H*1999).

***Polysiphonia flexicaulis** (Harvey) Collins

One record (July) on the open coast (Croasdale) and one (July) in the Estuary. Annual; cystocarpic plants found in July.

Recorded from Long Island to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 28 July 1938 (*Croasdale* 5471); Cedar Point, 10 July 1941 (*E. Flagg* 5473).

Polysiphonia harveyi Bailey

Reported by Collins (1900) and Doty and Newhouse (1954). No data or specimens available.

Recorded from South Carolina to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

Polysiphonia lanosa (Linnaeus) Tandy

Hemiparasitic on *Ascophyllum nodosum*. Common on the open coast, and with limited distribution in the Estuary. Present throughout the year. Perennial; tetraspores found from June to November; cystocarpic plants found from June to December; spermatia found from January to May.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5511); Jaffrey Point, 7 January 1967 (*H*2003); Fort Consti-

tution, 8 November 1966 (*H*2018); Odiorne's Point, 17 October 1966 (*H*2028); North Wallis Sands, 11 June 1967 (*H*2038); Concord Point, 10 August 1967 (*H*2051); Ragged Neck, 22 May 1967 (*H*2061); Rye Ledge, 15 October 1966 (*H*2062); Little Boar's Head, 24 May 1967 (*H*2083); Great Boar's Head, 25 July 1967 (*H*2095); Bound Rock, 18 January 1967 (*H*2096); Piscataqua River toll bridge, 24 June 1966 (*H*2098); Hilton Park, 28 August 1968 (*N. B. Reynolds* 273).

Polysiphonia nigra (Hudson) Batters

Found in the lower eulittoral (in tidepools) and the sublittoral zones. Occasional on the open coast, and with restricted distribution in the Estuary. Annual(?); tetraspores found in March and July; cystocarpic plants found from October to December.

Recorded from New Jersey to Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 8 November 1966 (*H*2102); Odiorne's Point, 7 August 1967 (*M*5562); North Wallis Sands, 7 August 1967 (*M*5564); Rye Ledge, 27 February 1968 (*M*5565); Bound Rock, 6 December 1966 (*H*2103); Hilton Park, 7 January 1967 (*H*2108); Cedar Point, 27 July 1966 (*H*2105); Durham Point, 16 October 1966 (*H*2113); Adams Point, 13 October 1966 (*H*2111).

Polysiphonia nigrescens (Hudson) Greville

Found throughout the year on rocks in the lower eulittoral and sublittoral zones on the open coast and throughout the Estuary. Frequent in drift. Perennial; tetraspores found from May to December; cystocarpic plants found in March and from June to September; spermatia found in February. Recorded from South Carolina to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 26 July 1938 (*Croasdale* 5586); Jaffrey Point, 8 November 1966 (*H*2129); Odiorne's Point, 10 March 1967 (*H*2119); North Wallis Sands, 10 September 1966 (*H*2122); Concord Point, 10 August 1967 (*H*2124); Ragged Neck, 23 November 1966 (*H*2126); Rye Ledge, 12 September 1966 (*H*2127); Bound Rock, 7 March 1966 (*M*5601); Hilton Park, 7 January 1967 (*H*2131); Cedar Point, 24 May 1967 (*H*2146); Durham Point, 3 March 1967 (*M*5632); Adams Point,

13 October 1966 (*H*2144); Fabyans Point, 16 November 1966 (*H*2150); Pierce Point, 18 October 1966 (*H*2154).

Polysiphonia novae-angliae Taylor

Found throughout the year on rocks and epiphytic on other algae in the lower eulittoral and sublittoral zones. Common on the open coast, and with restricted distribution in the Estuary. Perennial; tetraspores found January-December; cystocarpic plants found from June to November; spermatia found in February, March and May.

Recorded from Rhode Island to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (*M*5656); Jaffrey Point, 6 May 1967 (*M*5658); Fort Constitution, 24 July 1967 (*M*5659); North Wallis Sands, 20 March 1967 (*H*2156); Concord Point, 8 January 1967 (*H*2157); Ragged Neck, 10 August 1967 (*H*2159); Rye Ledge, 12 September 1966 (*H*2160); Great Boar's Head, 11 December 1966 (*H*2162); Bound Rock, 18 January 1967 (*H*2163); Piscataqua River toll bridge, 12 August 1967 (*H*2186); Hilton Park, 13 February 1967 (*H*2193); Cedar Point, 17 April 1967 (*H*2177); Durham Point, 15 December 1966 (*H*2181); Adams Point, 13 October 1966 (*H*2171).

***Polysiphonia subtilissima** Montagne

Found from June to October growing on rocks and mud in the lower eulittoral and sublittoral zones. Restricted to parts of the Estuary where salinities are very low. Annual; only one tetrasporic specimen was observed (July). Previously recorded from the tropics to Northern Massachusetts and with some doubt to the Baie de Gaspe (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Cedar Point, 27 June 1966 (*H*2118); Crommet Creek, 20 June 1966 (*M*5573); Squamscott River, 21 June 1966 (*H*2115).

Polysiphonia urceolata (Lightfoot *ex* Dillwyn) Greville

Growing on rocks in the lower eulittoral and sublittoral zones throughout the year. Common on the open coast and with restricted distribution in the Estuary. The seasonal varieties (*roseola* and *patens*) as designated by Taylor (1957) were not distinguishable. Perennial; tetraspores found from May to August; cystocarpic plants found in July and August; spermatia found from January to May.

Recorded from North Carolina to the arctic (as summarized in Taylor, 1957, including varieties *roseola* and *patens*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (*M*5727); Jaffrey Point, 9 August 1967 (*H*2204); Fort Constitution, 24 July 1967 (*M*5738); Odiorne's Point, 30 May 1967 (*H*2209); North Wallis Sands, 20 May 1967 (*H*2213); Concord Point, 27 June 1967 (*H*2215); Ragged Neck, 12 June 1967 (*H*2216); Rye Ledge, 24 July 1967 (*H*2217); Little Boar's Head, 24 May 1967 (*H*2222); Great Boar's Head, 24 January 1967 (*H*2225); Bound Rock, 20 February 1967 (*H*2228); Hilton Park, 14 October 1966 (*H*2235); Fox Point, 5 December 1966 (*H*2200).

Rhodomela confervoides (Hudson) Silva

Found throughout the year on the open coast in the low eulittoral and sublittoral zones. Perennial; tetraspores found in March and from May to August; cystocarpic plants found in June and July; spermatia found in March and April.

Recorded from New Jersey to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (*Kingsbury*, 1965); Jaffrey Point, 1 April 1967 (*H*2535); Fort Constitution, 22 June 1966 (*M*6031); Odiorne's Point, 7 August 1967 (*M*6032); North Wallis Sands, 28 February 1967 (*H*2536); Concord Point, 5 March 1967 (*H*2541); Ragged Neck, 12 December 1966 (*H*2544); Rye Ledge, 11 November 1966 (*H*2550); Little Boar's Head, 22 December 1966 (*H*2551); Great Boar's Head, 14 October 1966 (*H*2552); Bound Rock, 7 March 1966 (*H*2554).

DISCUSSION

Eighty-eight taxa of red algae are listed from the coastal and estuarine environments of New Hampshire; fifteen taxa represent additions to the flora of the state. Six taxa are doubtful records (*Polysiphonia harveyi*, *Bostrychia rivularis*, *Chondria tenuissima*, *Agardhiella tenera*, *Ceramium diaphanum*, *Batrachospermum* sp.).

Many of the plants are boreal and subarctic species (e.g., *Porphyra miniata*, *Euthora cristata*, *Rhodophyllis dichotoma*, *Gigartina stellata*, *Halosaccion ramentaceum*, *Ptilota serrata*, *Phyllophora* spp., *Polyides rotundus*, *Rhodochorton purpureum*). Certain components of the Estuary flora have

affinities towards warm temperate regions — in particular, the summer annuals whose center of distribution is south of New England (e.g., *Lomentaria baileyana*, *Dasya pedicellata*, *Spermothamnion repens*, *Polysiphonia denudata*, *Chondria baileyana*, *Gracilaria foliifera* and *Polysiphonia subtilissima*).

The paucity of information regarding seasonality and reproductive periodicity of marine algae of northern New England is due to a lack of seasonal collections. Winter observations are essentially nonexistent and little phenological data are available. In particular, those algae which have their growth or reproduction during late fall to early spring are apt to be missed (e.g., *Bangia fuscopurpurea*, *Plumaria elegans*, *Polysiphonia nigra*, *Porphyra linearis*, *Rhodochorton purpureum*). Edelstein and McLachlan (1966b) studied the occurrence and reproduction of marine algae during the winter months in Nova Scotia. Data from their study and the present investigation show many similarities.

The reproductive periodicities recorded for several species differ markedly from those listed in Taylor (1957). Several species reproduce throughout the year (e.g., *Porphyra umbilicalis*, *Audouinella membranacea*, *Hildenbrandia prototypus*, *Euthora cristata*, *Choreocolax polysiphoniae*, *Ahnfeltia plicata*, *Phyllophora brodiaei*, *Chondrus crispus*, *Gigartina stellata*, *Rhodymenia palmata*, *Ptilota serrata*, *Ceramium rubrum*, *Polysiphonia lanosa*, *P. nigrescens*, *P. novae-angliae*, *P. urceolata*), although they were reported to reproduce during only one or two seasons. Other species had more prolonged periods of reproduction than previously reported (e.g., *Petrocelis middendorfii*, *Antithamnion cruciatum*, *Membranoptera alata*, *Dasya pedicellata*). Reproductive specimens of *Plumaria elegans* were found in the fall and winter while Taylor reports reproduction from the summer and earlier. He describes *Porphyra miniata* as being reproductive during any season, giving the impression that it occurs throughout the year. According to our observations, *P. miniata* is an annual (spring and summer). It

was found to be reproductive every month in which it was found (March-August). Our observations on *P. miniata* are similar to those of Lamb and Zimmermann (1964).

The seasonal occurrence of most species generally agrees with those of Taylor (1957), except for *Bangia fuscopurpurea* and *Antithamnion floccosum* which differed slightly. *Bangia fuscopurpurea* occurred from late fall to late summer. Taylor records it from early spring and summer. *Antithamnion floccosum* was found from winter to late summer while Taylor records it only in the spring.

Both asexual and sexual structures were found. Monospores, bispores, paraspores and tetraspores were encountered. Tetraspores were the most common type. Monospores were found only in *Bangia fuscopurpurea*, *Kylinia* spp. and *Ahnfeltia plicata*. Bispores were found only in the crustose corallines, while paraspores were found exclusively in *Plumaria elegans*. Tetraspores were found in most other species. One conspicuous exception is *Gigartina stellata*, where the tetrasporophyte generation is unknown.

Certain plants were found only as tetrasporophytes (e.g., *Antithamnion cruciatum*, *A. floccosum*, *Audouinella membranacea*, *Ceratocolax hartzii*, *Cystoclonium purpureum* var. *cirrhosum*, *Dumontia incrassata*, *Melobesia lejolisii*, *Halosaccion ramentaceum*, *Hildenbrandia prototypus*, *Lomentaria baileyana*, *L. orcadensis*, *Membranoptera alata*, *Petrocelis middendorfii*, *Rhodochorton purpureum*, *Rhodymenia palmata*). Sexual generations have been described for most of these plants except *Halosaccion ramentaceum*, *Hildenbrandia prototypus* and *Rhodymenia palmata*.

Sexual structures were found on most species except those which produced monospores, bispores and paraspores. Female plants were more frequent than male plants. Some species produced cystocarps and spermatia at different times of the year (e.g., *Polysiphonia lanosa*, *P. nigrescens*, *P. novae-angliae*, *P. urceolata*, *Ptilota serrata*, *Rhodomela confervoides*). Others produced both structures at the same time (e.g., *Callithamnion baileyi*, *Dasya pedicellata*, *Rhycodrys rubens*, *Polysiphonia denudata*).

A distinct overlap in the occurrence of tetraspores and carpospores was noted for several species. *Callithamnion baileyi* and *Polysiphonia nigra* showed no distinct overlapping.

Three trends were evident:

(1) Tetraspores and carpospores were found throughout the year (e.g., *Ceramium rubrum*, *Chondrus crispus*, *Euthora cristata*, *Phycodrys rubens*).

(2) Tetraspores were found throughout the year while carpospores were found during only one or two seasons (e.g., *Polysiphonia urceolata*, *Choreocolax polysiphoniae*).

(3) Tetraspores and carpospores were present during one or more seasons. Both summer annuals (e.g., *Ceramium strictum*, *Dasya pedicellata*, *Chondria baileyana*, *Polysiphonia denudata*) and perennials (e.g., *Phyllophora membranifolia*, *Polyides rotundus*, *Polysiphonia elongata*, *P. lanosa*, *P. nigrescens*) were discernable.

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Table 1

Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, O = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Acrochaetium polyides	—	—	—	—	—	—	—	—	O	—	—	—
Ahnfeltia plicata	M	M	M	M	M	M	M	M	M	M	M	M
Antithamnion boreale	—	—	—	—	—	—	T	—	—	—	—	—
A. cruciatum	—	—	—	—	O	T	T	T	T	O	O	—
A. floccosum	O	O	O	T	O	—	—	T	—	—	—	—
A. plumula	—	—	—	—	—	—	O	—	—	—	—	—
A. pylaisaei	—	—	—	—	O	—	—	—	—	—	—	—
Audouinella membranacea	T	T	T	T	T	T	T	T	T	T	T	T
Bangia ciliaris	—	—	—	—	—	O	—	—	—	—	—	—
B. fuscopurpurea	M	M	M	M	O	O	O	O	—	—	O	M
Bonnemaisonia hamifera	—	—	—	O	—	O	O	—	—	—	—	—
Callithamnion baileyi	O	—	T	—	O	—	T,C,S	C	C,S	C,S	O	—
C. corymbosum	—	—	—	—	—	—	T	—	—	—	—	—
Ceramium deslongchampsii var. *hooperi*	—	—	—	O	O	O	O	T	O	O	O	—
C. rubriforme	—	—	—	—	—	—	O	—	—	—	—	—
C. rubrum	C,T	C,T	C,T	C,T	T	C,T	C,T	C,T	C,T	C,T	C,T	C,T
C. strictum	—	—	—	—	—	C,T	C,T	C,T	C,T	C,T	—	—
Ceratocolax hartzii	T	T	O	T	T	—	O	O	—	—	O	O
Chondria baileyana	—	—	—	—	—	T	C,T	C,T	C,T	O	O	—

Table 1 (continued)

Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, O = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Chondrus crispus	C,T	C,T	C,T	C,T	C,T	T	C,T	T	C,T	C,T	C,T	T
Choreocolax polysiphoniae	T	T	T	T	T	T	C,T	C,T	T	T	C,T	T
Clathromorphum circumscriptum	B	B	B	B	B	O	O	O	O	O	O	B
Corallina officinalis	O	O	O	O	O	O	O	O	O	O	O	O
Cystoclonium purpureum var. *cirrhosum*	O	O	O	T	T	T	T	T	T	T	T	O
Dasya pedicellata	—	—	—	—	—	—	T,C,S	T,C,S	T,C,S	T,C,S	C,S	O
Dermatolithon pustulatum	B	B	B	O	B	B	B	B	B	B	B	B
Dumontia incrassata	O	O	T	T	T	T	T	T	O	O	O	O
Erythrotrichia carnea	—	O	—	—	—	—	—	—	O	—	O	—
Euthora cristata	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T
Gigartina stellata	C	C	C	C	C	C	C	C	C	C	C	C
Gloiosiphonia capillaris	—	—	—	—	—	—	C	—	—	—	—	—
Gracilaria foliifera	—	—	O	C	O	C,T	C,T	C,T	C,T	C,T	C	O
Halosaccion ramentaceum	T	T	T	T	T	T	T	T	T	T	O	T
Hildenbrandia prototypus	T	T	T	T	T	T	T	T	T	T	T	T
Kylinia alariae	—	—	—	—	—	—	M	O	—	—	—	—
K. secundata	M	M	M,T	M	M	M	M	M	M	M	M	M
K. virgatula	—	—	—	—	—	—	—	—	M	M	—	M
K. virgatula f. *luxurians*	—	—	—	—	—	—	M	—	M	—	—	—

Table 1 (continued)

Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carpospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, O = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Lithophyllum corallinae	O	O	B	O	O	B	B	O	O	O	O	O
Lithothamnium glaciale	—	B	O	B	O	O	O	O	O	O	O	—
Lomentaria baileyana	—	—	—	—	—	—	T	T	O	O	O	—
L. orcadensis	—	—	—	—	—	—	—	T	—	O	—	—
Melobesia lejolisii	T	T	T	T	T	T	O	O	O	T	T	T
Membranoptera alata	T	T	T	T	T	T	T	O	O	O	T	T
Nemalion helminthoides	—	—	—	—	—	—	O	C	—	—	—	—
Pantoneura baerii	—	—	—	—	T	O	—	—	—	—	—	—
Petrocelis middendorfii	T	T	T	T	T	T	O	O	O	T	T	T
Peyssonelia rosenvingii	O	—	—	O	—	—	—	—	—	—	—	—
Phycodrys rubens	C,T	C,T	C,T	C,T	C,T	C,T	T,C,S	C	O	T	C,T	C,T
Phyllophora brodiaei	N	N	N	N	N	N	N	N	N	N	N	N
P. membranifolia	C,T	T	C,T	C	O	O	O	O	T	T	C,T	T
P. traillii	—	—	—	—	—	—	O	—	—	—	—	—
Phymatolithon lenormandi	C,T	O	—	O	O	O	O	—	O	O	O	O
Plumaria elegans	—	O	O	O	O	O	O	O	P	P	P	P
Polyides rotundus	P	C	O	O	O	O	O	O	O	C,T	C,T	C,T
Polysiphonia denudata	—	—	—	—	—	—	C,T	C,T	C,T	T	O	O
P. elongata	O	O	O	O	O	T	T,C,S	T	T	O	O	O
P. flexicaulis	—	—	—	—	—	—	C	—	—	—	—	—

Table 1 (continued)

Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carpospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, O = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
P. lanosa	S	S	S	S	S	C,T	C,T	C,T	C,T	C,T	C,T	C
P. nigra	O	O	T	—	—	—	T	O	O	C	C	C
P. nigrescens	O	S	C	O	T	C,T	C,T	C,T	C,T	T	C,T	C,T
P. novae-angliae	T	T,S	T,S	T	T,S	C,T	C,T	C,T	C,T	C,T	C,T	T
P. subtilissima	—	—	—	—	—	O	T	O	O	O	—	—
P. urceolata	S	S	S	S	T,S	T	C,T	C,T	O	T	T	O
Porphyra leucosticta	O	—	α,β	α,β	B	O	O	—	—	—	—	—
P. linearis	O	B	B	α	α	—	—	—	—	—	—	O
P. miniata	—	—	B	α,β	α,β	α,β	α,β	α,β	—	—	—	—
P. umbilicalis	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β
P. umbilicalis f. *epiphytica*	B	B	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α,β	α
Porphyropsis coccinea	—	—	—	—	—	—	—	O	—	—	—	—
Ptilota serrata	T	T,S	T,S	T	C,T	T	O	O	S	S	T,S	T,S
Rhodochorton purpureum	O	T	O	O	O	O	O	O	O	O	O	O
Rhodomela confervoides	O	O	T,S	S	T	C,T	C,T	T	O	O	O	O
Rhodophyllis dichotoma	T	C	—	—	C	C	T	—	—	—	—	—
Rhodophysema georgii	—	T	O	O	O	—	O	—	O	O	T	—
Rhodymenia palmata	T	T	T	T	T	T	T	T	T	T	T	T
Spermothamnion repens	—	—	O	—	—	—	T	O	O	—	—	—
Trailliella intricata	—	—	—	—	—	—	O	—	—	—	—	—

HYBRIDS IN RUBUS SUBGENUS EUBATUS IN NEW ENGLAND[1, 2]

FREDERIC L. STEELE
AND
A. R. HODGDON

The background for this current study will be found in the three papers we have published on New England blackberries during the past nine years, beginning in 1962[3, 4, 5]. Aside from the cited paper on hybrids of *Rubus hispidus* and *R. setosus*, we have thus far made no attempt to characterize hybrids in the group. In our survey of New England blackberries in 1966 we thought it would have unduly complicated our study to have done so. However, at that time we were fully aware of the significance of hybridization as we indicated in the long list of rejected binomials on pp. 510-512 where, in each instance when we suspected that a name had been given to a hybrid, we also stated what we supposed the parentage to be.

The present paper then is an attempt to round out our studies on *Rubus* in New England. We have accumulated a great deal of data in the course of field and laboratory work, much of it serving to support our contention and that of some others before us that it is chiefly the high incidence of interspecific hybridization that makes classification so difficult in blackberries. Therefore, our study of New

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[2]This research has been supported by the New Hampshire Agricultural Experiment Station and by grants from the Central University Research Fund of the Graduate School of the University of New Hampshire and from the Northern New England Academy of Science.

[3]Hodgdon, A. R. & F. L. Steele. 1962. Glandularity in *Rubus allegheniensis* Porter. Rhodora *64:* 161-168.

[4]Steele, F. L. & A. R. Hodgdon. 1963. Hybridization of *Rubus hispidus* and *R. setosus*. Rhodora *65:* 262-270.

[5]Hodgdon, A. R. & F. L. Steele. 1966. *Rubus* subgenus Eubatus in New England. Rhodora *68:* 474-513.

England *Rubus* would be incomplete unless we gave due consideration to hybrids.

The following treatment includes those intermediates that we have observed and collected often enough to feel we have definite evidence of their hybrid nature. We are equally certain that there are some other hybrid combinations yet to be determined since we have never, for any very long period of time, failed to discover new ones. There have been found, by us and others before us, some very unusual plants that we hesitate to evaluate; presumably these may have resulted from crossing but we will ignore them in the present treatment.

In what we may for convenience designate the *flagellaris* group of blackberries the following species, *Rubus flagellaris*, *R. Jaysmithii*, *R. arenicola* and *R. recurvicaulis* seem to hybridize freely. At least there are overlapping tendencies between them and it is difficult to separate them clearly when they meet. However, it is often difficult to distinguish hybrids from unusual states of growth such as depauperate forms within the species. Also, especially on herbarium sheets, it is difficult to know which particular parents are involved. For these reasons any suspected hybrids among these four species have been omitted from the present treatment. The cross between *R. Enslenii* and *recurvicaulis* however, seemed to be clear enough to recognize both parents.

The *flagellaris* group of species, which are very closely related and differ only in habit and minor aspects, would be difficult to distinguish at the species level as parents of crosses with other blackberries. Therefore, we have had to identify the parents arbitrarily on the basis of what seemed most likely at the particular site where the hybrid was observed. Usually this was possible to do because only *Rubus flagellaris* and *R. recurvicaulis* are widespread and common. Also, more often than not, one of these but not both occur in the immediate vicinity of a hybrid population. In ordinary herbarium material such hybrids would necessarily have to remain in question as to exact parentage.

In the following treatment the names in parentheses that are given directly after some of the hybrid designations are binomials, in most cases rejected ones, which we consider to be equivalent to these hybrids.

For convenience the generic name *Rubus* is omitted in the following listing of hybrids. Descriptions and discussions of the species involved and author's names of the binomials may be found in our 1966 study (loc. cit.).

flagellaris × **allegheniensis.** *Low doming to 2 ft or almost trailing*; leaflets 5, rather narrow, 7 to 11 cm long, slightly pubescent underneath; primocanes *5 mm in diameter*; armature of slender, hooked to straight prickles and *occasional glands*; inflorescence straggling, up to 11 cm, the *axis and pedicels with frequent glands.*

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Edgecomb, *Hodgdon* 7231 (NHA); Boothbay, *Hodgdon* 10933 (NHA). NEW HAMPSHIRE: CARROLL CO., Sandwich, *Steele* 3750 (STEELE); SULLIVAN CO., Claremont, *Hodgdon & Steele* 10198 (NHA). MASSACHUSETTS: WORCESTER CO., Mendon, *Hodgdon & Steele* 18051 (NHA).

flagellaris × **frondosus.** *Arching to doming and trailing*; leaflets medium to large, 7 to 9 cm long, compound leaves 14 cm across, pubescent underneath; canes 3 to 4 mm in diameter; armature of hooked prickles; inflorescence spreading, 2-6 flowered; *axis pubescent but no glands present.*

REPRESENTATIVE SPECIMENS: NEW HAMPSHIRE: STRAFFORD CO., Durham, *Hodgdon & Steele* 12486 (NHA). MASSACHUSETTS: BARNSTABLE CO., Harwich, *Hodgdon & Steele* 3923 (STEELE). CONNECTICUT: TOLLAND CO., Tolland, *Hodgdon & Steele* 18052 (NHA); Stafford Springs, *Steele & Hodgdon* 3923 (STEELE).

Jaysmithii × **hispidus.**

REPRESENTATIVE SPECIMEN: RHODE ISLAND: WASHINGTON CO., Block Island, *Champlin* 7/4/67 (NEBC).

Jaysmithii × **elegantulus.** Similar to *recurvicaulis* × *elegantulus* but with leaves slightly pubescent beneath.

REPRESENTATIVE SPECIMEN: VERMONT: WINDHAM CO., Westminster, *Hodgdon & Steele* 11372 (NHA).

Enslenii × recurvicaulis. Trailing to low doming or arching, 1-2 ft. high; *leaflets smooth, small to medium, 3-5, glabrous*; prickles sparse to medium; inflorescence 2-3.5 cm long, of the *recurvicaulis*-type, flowers 1-4, pedicels short, slender.

REPRESENTATIVE SPECIMENS: MAINE: YORK CO., *Hodgdon & Steele* 18050 (NHA). NEW HAMPSHIRE: STRAFFORD CO., Durham, *Steele & Hodgdon* 4099 (STEELE).

Enslenii × pensilvanicus *(R. frondosus)*. Arched or trailing; *leaflets 3-5, larger than Enslenii*, compound leaves up to 13 cm across, sparsely pubescent underneath; *stems slender, 2.5 mm in diameter*; prickles thin and slender, rather sparse; inflorescence up to 8 cm long, flowers 1-5, pedicels 2-6 cm long, glandless.

REPRESENTATIVE SPECIMEN: NEW HAMPSHIRE: STRAFFORD CO., Durham, *Hodgdon* 12197 (NHA).

recurvicaulis × hispidus. Trailing; *leaflets 3 to 5, chartaceous, not lustrous*; *armature of short prickles, bristles and glands*; inflorescence short, compact, 4 × 2 cm, 6 to 10-flowered.

REPRESENTATIVE SPECIMENS: NEW HAMPSHIRE: GRAFTON CO., Woodstock, *Hodgdon & Steele* 11356 (NHA); ROCKINGHAM CO., Seabrook, *Hodgdon & Steele* 11386 (NHA). MASSACHUSETTS: ESSEX CO., Salisbury, *Steele* 3519 (STEELE).

recurvicaulis × setosus *(R. multiformis)*. *Doming or trailing*; leaflets (3) 5, rather narrow, subchartaceous, glabrous, medium to large, compound leaves up to 18 cm across; canes about 3 mm in diameter; *armature of slender prickles with few to many bristles intermixed*; inflorescence of the *setosus* type, up to 9 cm long, axis and pedicels with glands.

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Boothbay, *Hodgdon & Steele* 7524 (NHA); SAGADAHOC CO., Arrowsic, *Hodgdon* 7524 (NHA). NEW HAMPSHIRE: CARROLL CO., Tamworth, *Steele* 3832 (STEELE); GRAFTON CO., North Woodstock, *Fernald* 362 (NHA).

recurvicaulis × vermontanus *(R. severus)*. Arching or doming; leaves glabrous, often chartaceous, ovate to lanceolate; *armature of numerous sharp slender prickles*, straight to hooked, up to 200 per dm.

REPRESENTATIVE SPECIMENS: MAINE: CUMBERLAND CO., Harpswell, *Hodgdon & Steele* 12375 (NHA). NEW HAMPSHIRE: CARROLL CO., Ossipee, *Steele* 3477 (STEELE), Conway, *Steele* 2937 (STEELE); GRAFTON CO., Thornton, *Hodgdon* 11347 (NHA), Waterville, *Hodgdon & Steele* 11306 (NHA); HILLSBORO CO., Nashua, *Steele* 2763 (STEELE). MASSACHUSETTS: ESSEX CO., Plum Island, *Hodgdon & Steele* 15543 (NHA).

recurvicaulis × **elegantulus.** Arching, doming or trailing; *leaflets large, subchartaceous*, lateral petioles often short, terminal ones short to long, leaflets glabrous; canes stout; *spines thin*; *inflorescence as in elegantulus, no glands on axis.*

REPRESENTATIVE SPECIMENS: MAINE: YORK CO., York, *Hodgdon & Steele* 12260 (NHA). NEW HAMPSHIRE: CARROLL CO., Sandwich, *Steele* 3783 (STEELE).

recurvicaulis × **allegheniensis.**

REPRESENTATIVE SPECIMEN: MAINE: KNOX CO., Vinal Haven, *Bean* 6/25/34 (NEBC).

recurvicaulis × **frondosus.** This is very similar to *flagellaris* × *frondosus* described above. Distinction depends on the putative parents that are present.

REPRESENTATIVE SPECIMENS: MAINE: YORK CO., Wells, *Fernald* 13872 (NEBC). MASSACHUSETTS: BARNSTABLE CO., Harwich, *Fernald* 16899 (NEBC).

recurvicaulis × **pensilvanicus.** Low-doming to *2 ft*; leaflets 5 of medium-size, slightly pubescent beneath; *primocanes stouter* than those of *recurvicaulis* (about 5 mm in diameter); armature of slender, hooked to straight prickles, without glands; inflorescence variable, *axis without glands.*

REPRESENTATIVE SPECIMENS: MAINE: PENOBSCOT CO., Bangor, *Fernald* 13871 (NEBC). NEW HAMPSHIRE: BELKNAP CO., Laconia, *Fernald* 15680 (NEBC).

arenicola × **semisetosus.** (Tentative, needs further study); Arching or trailing; leaves chartaceous, soft-velvety beneath; armature of stout, hooked prickles; inflorescence of the *setosus* type, *axis with slender prickles and glands.*

REPRESENTATIVE SPECIMEN: NEW HAMPSHIRE: ROCKINGHAM CO., Seabrook, *Steele* 2770 (STEELE).

hispidus × **setosus** *(R. adjacens, R. jacens, R. trifrons).* Doming or trailing; *leaflets 3 to 5, sublustrous*; armature of prickles, bristles and glands, from 2000-3000 per dm; inflorescence with some glands on axis.

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Monhegan Island, *Hodgdon* 12773 (NHA); Boothbay, *Hodgdon* 12272 (NHA). NEW HAMPSHIRE: CARROLL CO., Sandwich, *Steele* July 6, 1960 (NHA); Tamworth, *Steele*, Aug. 11, 1961 (NHA); GRAFTON CO., Thornton, *Hodgdon & Steele* 11345 (NHA); BELKNAP CO., Alton, *Hodgdon & Steele* 12193 (NHA); MERRIMACK CO., Newbury, *Hodgdon & Steele* 15484 (NHA); Pittsfield, *Hodgdon & Steele* 12790 (NHA); Danbury, *Hodgdon & Steele* 12789 (NHA); HILLSBORO CO., Litchfield, *Hodgdon & Steele* 16395 (NHA). MASSACHUSETTS: NORFOLK CO., Medway, *Hodgdon & Steele*, Sept. 2, 1964 (NHA); WORCESTER CO., Sterling, *Hodgdon & Steele*, July 13, 1964 (NHA).

The cross between *Rubus hispidus* and *R. setosus* has been discussed earlier by us (1963) and is probably the most frequently occurring of any blackberry hybrid in New England.

hispidus × **vermontanus.** Resembles *hispidus* × *setosus* but prickles stiffer. Trailing to arching; leaflets 3-5, larger than *hispidus*; compound leaves averaging 8 × 8 cm, sublustrous, subcoriaceous, glabrous both sides; armature of glands, bristles and *definite short, stiff, hooked prickles.*

REPRESENTATIVE SPECIMENS: MAINE: HANCOCK CO., Somesville, Mt. Desert Island, *Rand* sn. (NEBC); LINCOLN CO., Southport, *Hodgdon* 7224 (NHA). NEW HAMPSHIRE: CARROLL CO., Tamworth, *Steele* 3992 (STEELE); GRAFTON CO., Waterville, *Steele* 2922 (STEELE); STRAFFORD CO., Barrington, *Hodgdon & Steele* 15560 (9 collections, both putative parents present) (NHA), Rochester, *Hodgdon* 3461 (NHA); MERRIMACK CO., Wilmot, *Hodgdon & Steele* 9424 (NHA); ROCKINGHAM CO., Northwood, *Hodgdon & Steele* 11212 (NHA); Nottingham, *Hodgdon* 9663 (NHA); Hampton Falls, *Hodgdon & Steele* 11213 (NHA). VERMONT: ESSEX CO., Ferdinand, *Pease* 25694 (NEBC); ADDISON CO., Leicester, *Brainerd* sn. (NEBC). MASSACHUSETTS: MIDDLESEX CO., *Carlisle, Hodgdon & Steele* 15563 (NHA).

hispidus × **allegheniensis** *(R. permixtus).* Trailing or doming; leaves subcoriaceous, lustrous, *pubescent underneath,* leaflets ovate or elliptic, 6-8 cm long, compound leaf averaging 13 cm × 13 cm; canes 2-4 mm in diameter;

armature of short, stiff, hooked prickles and glands intermixed; inflorescence small to medium, often with juicy fruits.

REPRESENTATIVE SPECIMENS: NEW HAMPSHIRE: CARROLL CO., Tamworth, *Steele* sn. (STEELE): ROCKINGHAM CO., Northwood, *Hodgdon & Steele* 11318 (NHA).

setosus × vermontanus *(R. Groutianus, Parlinii, univocus).* Growth habit and aspect like *setosus* and *vermontanus*; *armature of glands*, bristles of various lengths and at least some acicular prickles *resistant to touch* and numerous (100), 1000-3000 per dm. Usually resembling *setosus* more than *vermontanus*; distinguished from *setosus* × *elegantulus* only by presence of putative parents.

REPRESENTATIVE SPECIMENS: MAINE: PISCATAQUIS CO., Dover Foxcroft, *Fernald* (NEBC); YORK CO., York, *Steele* 4055 (NHA). NEW HAMPSHIRE: COOS CO., Columbia, *Hodgdon & Rhoades* 15666 (NHA); Randolph, *Hodgdon* 11178 (NHA); Groveton, *Hodgdon* 12198 (NHA); Northumberland, *Hodgdon & Steele* 11179 (NHA); CARROLL CO., Sandwich, *Steele* 4044 (NHA); Wakefield, *Steele* 4053 (NHA); Tuftonboro, *Hodgdon & Steele* 12268 (NHA); GRAFTON CO., Waterville, *Hodgdon & Steele* 11175 (NHA); Orange, *Hodgdon & Steele* 11268 (NHA); Grafton, *Steele* 3403 (STEELE); STRAFFORD CO., Barrington, *Hodgdon & Steele* 15540 (NHA); Madbury, *Hodgdon* 14567 (NHA); BELKNAP CO., Alton, *Hodgdon & Steele* 12190 (NHA); MERRIMACK CO., Pittsfield, *Steele* 4057 (NHA); ROCKINGHAM CO., Northwood, *Hodgdon & Steele* 11191 (NHA); Hampton Falls, *Steele* 3434 (STEELE); HILLSBORO CO., Sharon, *Hodgdon* 7237 (NHA). VERMONT: WINDHAM CO., Westminster, *Steele* 3478 (STEELE); ESSEX CO., Victory, *Pease* 28414 (NEBC). CONNECTICUT: TOLLAND CO., Tolland, *Steele* 3882 (STEELE); HARTFORD CO., Berlin, *Steele* 3881 (STEELE).

setosus × semisetosus. Resembles *setosus* but with thin pubescence and small prickles on veins on under side of leaves.

REPRESENTATIVE SPECIMEN: MASSACHUSETTS: NORFOLK CO., Medway, *Steele* 3946 (STEELE).

setosus × elegantulus. Doming to arching, 2-4 ft, leaflets rather large, like *elegantulus*, leaflets ovate to lanceolate, subchartaceous to membranaceous; *armature of sparse to abundant thin prickles and bristles*, often with glands. Very

close to *setosus* × *vermontanus*; best distinguished from it by presence of putative parents.

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Ocean Point, *Fassett* 814 (NEBC). NEW HAMPSHIRE: COOS CO., Dummer, *Steele* 2952 (STEELE); CARROLL CO., Tuftonboro, *Steele* 3784 (STEELE); Tamworth, *Steele* 3837 (STEELE); SULLIVAN CO., Sunapee, *Steele & Hodgdon* 4077 (STEELE).

setosus × allegheniensis *(R. frondisentis, sceleratus, aculiferus).* Arching to erect, 2-4(5) ft; *armature of straight strong prickles, setose bristles and glandular hairs*; leaves membranaceous to subchartaceous, resembling *allegheniensis*, with *slight to abundant pubescence underneath*; axis of inflorescence pubescent and glandular; inflorescence smaller than typical *allegheniensis*; fruit poor and often undeveloped.

REPRESENTATIVE SPECIMENS: MAINE: KNOX CO., Isle au Haut, *Kidder* 8/29/19, (NEBC). NEW HAMPSHIRE: COOS CO., Northumberland, *Fernald & Pease* (NEBC); 15779 (NEBC); Randolph, *Fernald & Pease* 15781 (NEBC); Dummer, *Hodgdon & Steele* 11280 (NHA); CARROLL CO., Tamworth, *Steele* 704 (STEELE); N. Conway, *Steele* 4045 (STEELE); Sandwich, *Steele* 4043 (STEELE); GRAFTON CO., N. Woodstock, *Hodgdon & Steele* 11304 (NHA); Woodstock, *Hodgdon & Steele* 12374 (NHA); Lisbon, *Steele* 3537 (STEELE); MERRIMACK CO., Hooksett, *Hodgdon* 7213 (NHA); ROCKINGHAM CO., Rye, *Steele* 4067 (STEELE); Seabrook, *Steele* 2771 (STEELE); VERMONT: WINDHAM CO., Dummerston, *Brainerd* 269001 (NEBC).

vermontanus × semisetosus. Resembles *semisetosus* but pubescence thin or present only on nerves.

REPRESENTATIVE SPECIMENS: MASSACHUSETTS: ESSEX CO., Newburyport, *Steele* 3836 (STEELE). CONNECTICUT: Fairfield Co., New Canaan, *Steele* 3948 (STEELE).

vermontanus × elegantulus. This hybrid undoubtedly occurs often but the 2 species are so similar at times that the cross can be identified positively only by the presence of both putative parents.

REPRESENTATIVE SPECIMENS: NEW HAMPSHIRE: GRAFTON CO., North Woodstock, *Steele* 2949 (STEELE); Thornton, *Steele* 2929 (STEELE).

vermontanus × **allegheniensis.** Arching, 2-4 ft; *leaves* medium to large, *pubescent underneath*; canes 3-5 mm in diameter; *armature of slender prickles*, often with glands intermixed, prickles shorter and thinner than typical *allegheniensis*; inflorescence like *allegheniensis* but somewhat smaller and poor-fruiting, axis with few to many glands.

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Boothbay, *Hodgdon* 12261 (NHA). NEW HAMPSHIRE: CARROLL CO., Sandwich, *Steele* 4035 (NHA); Tamworth, *Steele* 3804 (STEELE); Bartlett, *Steele* 3996 (STEELE); GRAFTON CO., Thornton, *M. L. Fernald* 15710 (NEBC); Woodstock, *Steele* 2927 (STEELE); STRAFFORD CO., Barrington, *Hodgdon & Steele* 15539 (NHA).

semisetosus × **frondosus.** Arching, 2-4 ft; leaves of medium-size, compound leaf over 14 cm across, pubescent underneath; canes 3-5 mm in diameter; *prickles thin, 2-4 mm long*; numerous, up to 30 per dm; inflorescence of the *vermontanus* type, *axis pubescent, no glands*; fruit poor.

REPRESENTATIVE SPECIMEN: MASSACHUSETTS: NORFOLK CO., Millis, *Hodgdon & Steele* 18290 (NHA).

canadensis × **elegantulus.** Undoubtedly occurs often, but parents are too closely related to identify this hybrid unless both putative parents are present.

REPRESENTATIVE SPECIMEN: NEW HAMPSHIRE: GRAFTON CO., Lincoln (Norcross Pond 3000 ft), *Steele* 3711 (STEELE).

canadensis × **allegheniensis.** Leaves like *allegheniensis*, pubescent underneath; *armature of sparse, short, thin prickles*; *axis of inflorescence with occasional glands.* Resembles a state of *pensilvanicus.*

REPRESENTATIVE SPECIMENS: MAINE: PISCATAQUIS CO., Dover, *Fernald* 9394 (NEBC). NEW HAMPSHIRE: CARROLL CO., Madison, *Steele* 3991 (STEELE); Tamworth, *Steele* 3967 (STEELE).

canadensis × **pensilvanicus.** *Leaves* as in canadensis but with *light pubescence underneath* or pubescent on nerves; *armature of sparse, thin prickles*, 0-7 per dm; axis of inflorescence pubescent with occasional glands.

REPRESENTATIVE SPECIMENS: MAINE: LINCOLN CO., Boothbay, *Fassett* 480 (NEBC). NEW HAMPSHIRE: COOS CO., Gorham, *Fernold &*

Pease 15672 (NEBC); Errol, *Fernald & Pease* 15674 (NEBC); CARROLL CO., Sandwich, *Steele* 2971 (STEELE); GRAFTON CO., Bath, *Fernald* 15692 (NEBC); Lincoln, *Fernald* 15730 (NEBC).

elegantulus × **allegheniensis.** *Leaves* pubescent, resembling those of *allegheniensis, subchartaceous*; *prickles thin, numerous*, resembling those of *elegantulus*; *axis of inflorescence with glands.*

REPRESENTATIVE SPECIMEN: NEW HAMPSHIRE: CARROLL CO., Sandwich, *Steele* 3778 (STEELE).

allegheniensis × **pensilvanicus.** Leaves with sparse pubescence; *armature of scattered, short, thin prickles*; axis of inflorescence with some glands.

REPRESENTATIVE SPECIMENS: MAINE: ANDROSCOGGIN CO., Poland, *Furbish* 1895 sn. (NEBC); KNOX CO., Matinicus, *Long* 7/1/20 sn. (NEBC); PISCATAQUIS CO., Dover, *G. B. Fernald* 115 (NEBC). NEW HAMPSHIRE: STRAFFORD CO., Lee, *Hodgdon* 7263 (NHA); ROCKINGHAM CO., Hampton, *Steele* 3516 (STEELE).

allegheniensis × **frondosus.** *Leaves* pubescent beneath, of medium size, *subchartaceous*, with well-marked veins; armature of stout prickles; *axis of inflorescence with scattered glands.*

REPRESENTATIVE SPECIMEN: RHODE ISLAND: WASHINGTON CO., Block Island, *Champlin* sn. (NEBC). This is probably a frequent hybrid within the range of both parents.

In summary we make the following appraisal of hybridization-potential in *Rubus* subgenus Eubatus in New England.

The following species hybridize frequently: *Rubus hispidus, R. setosus, R. vermontanus, R. semisetosus, R. allegheniensis, R. pensilvanicus* and *R. frondosus.*

The following species often placed in the Series Flagellares presumably hybridize easily amongst themselves but less commonly with other species: *Rubus flagellaris, R. recurvicaulis, R. Jaysmithii, R. arenicola* and *R. Enslenii.*

There are some species that tend to hybridize rarely: *Rubus canadensis* and *R. elegantulus.*

Mostly because of their scarcity we know little about the hybridizing capacity of *Rubus argutus* and *R. cuneifolius*.

ST. MARY'S-IN-THE-MOUNTAINS
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CHRYSANTHEMUM LACUSTRE BROTERO NEW TO GRAY'S MANUAL RANGE

During a collecting trip on August 15, 1968, along the western edge of Back Bay, Virginia Beach, Virginia, (formerly Princess Anne County) in the southeastern corner of the state, two specimens of an unidentified composite were secured. The plants, one in flower, the other rather advanced in age, were determined by Dr. A. M. Harvill, Jr. to be *Chrysanthemum lacustre* Brotero, a species native to Portugal (Bailey, L. H. 1924. Manual of Cultivated Plants.) They were found by a roadside where the grassy shoulder bordered a marsh near Mill Dam Landing.

Although a new record for Virginia, as well as the range of Gray's Manual, this plant has been reported as infrequent in old fields and ditches in Brunswick, Chowan, and Stanly Counties, North Carolina, and Abbeville County, South Carolina. (Radford, Ahles, and Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill, N. C.)

The specimens are deposited in the herbarium of Longwood College, Virginia.

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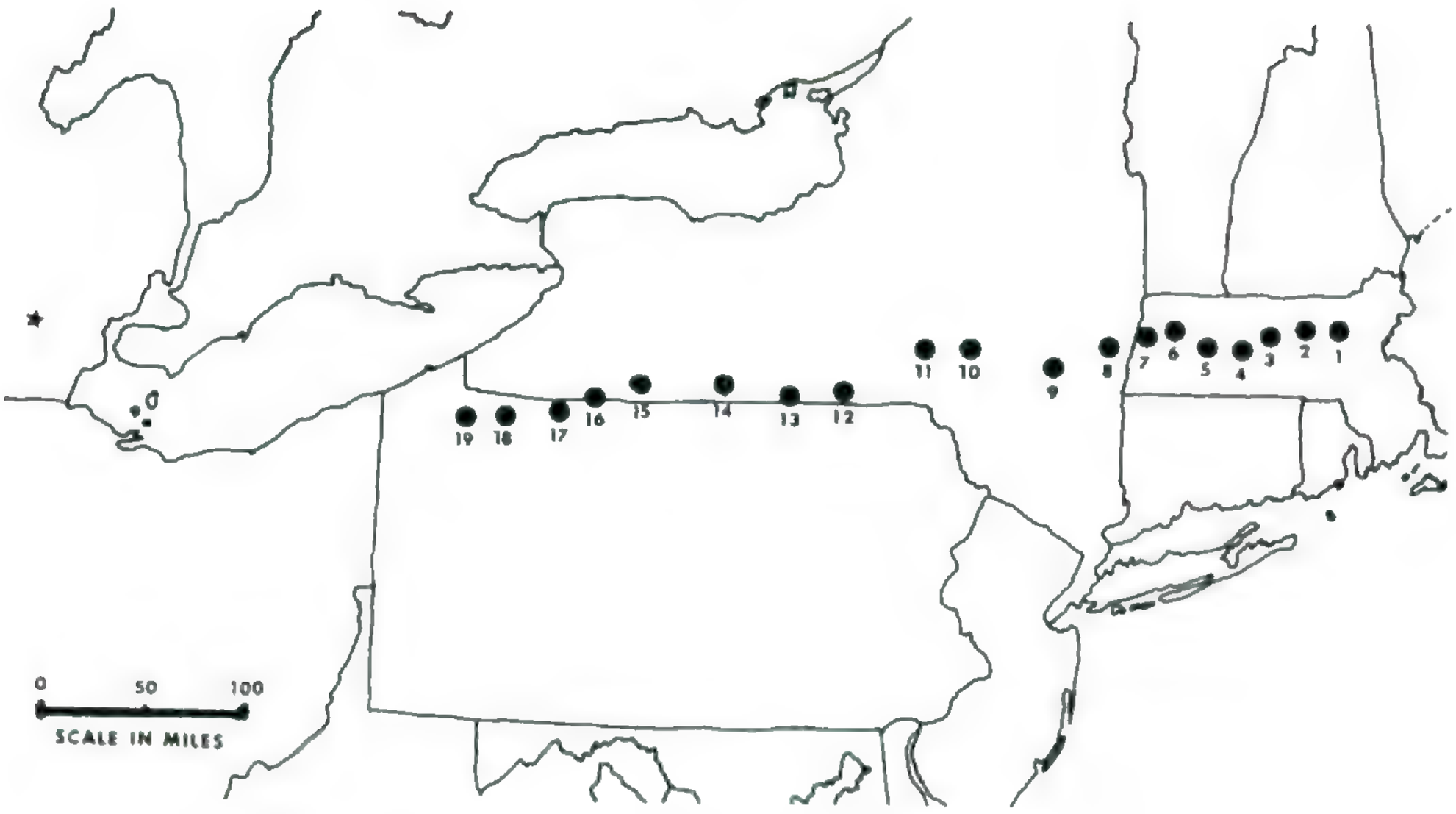
SOIL PREFERENCES AND VARIATION IN FLAVONOID PIGMENTS IN SPECIES OF ASTER

WARREN G. ABRAHAMSON AND OTTO T. SOLBRIG

A plant has certain environmental limits within which it can operate with greater or lesser success. The characteristics of the phenotype will determine the relative success of the plant. The environment is not static, but variable both in time and in space. For a species to occupy more than a point in time and in space, it has to have the ability to operate successfully under different environmental conditions. Two major mechanisms help the plant cope with a variable environment: (1) adjusting its phenotype and its metabolism through physiological and developmental responses so that the phenotype be as close to optimum as possible for the prevailing situation; (2) adapting genetically through the production of a great array of diverse genotypes and an excess of progeny, from which presumably only the best suited will grow to maturity.

The purpose of these studies is to determine the various facets involved in the adaptation of a species to conditions that vary in space and in time. The dilemma for the investigator is how to establish both the environmental factors that limit the distribution of a species, and also the phenotypical and genetical characteristics that make the distribution possible, given that neither the environment nor the morphological and genetical characteristics are constant in time and space. One classical technique is that of transplant experiments. Population samples are grown under a relatively uniform environment, and compared to one another. The differences that are found are presumably responsible for the capacity of the two populations to grow in different habitats. There are several problems in this method that will be discussed, but in general it has provided interesting information.

The genus *Aster* is widespread, common, and taxonomically difficult. In the northeastern United States there is



(See Collection Data on page 262)

ample evidence of repeated hybridization (Wetmore and Delisle, 1939; Uttal, 1962), as well as polyploidy (Van Faasen, 1963; Solbrig, 1967). Avers (1953a, b) was able to document both hybridization and polyploidy in the heterophylli group, and also some degree of chromosomal homology, crossing relationships and possible phylogeny. For this reason it was felt that this group would be amenable to more in depth ecological studies, than any other group of Asters.

MATERIALS AND METHODS

A transect was established nearly due west from Boston to the general area of the corner of the states of Pennsylvania, New York, and Ohio (fig. 1). Along this transect a population was sampled every twenty to fifty miles. The sample was restricted to populations belonging to the heterophylli group of *Aster* (Fernald, 1950; Avers, 1953b). Each sample consisted of at least ten plants and not more than twenty, and these were selected at random. The plants were brought to the Botanical Gardens of the University of Michigan in Ann Arbor, Michigan where they were broken into two clones and both halves were then planted in a uniform garden following a randomized design. In addition a soil

sample was gathered in a plastic bag at most of the localities and brought to the laboratory for analysis.

Soil Analysis

Soil samples were characterized as to pH, moisture retention capacity, nitrate content, and mechanical composition.

The hydrometer method was used for the mechanical analysis. Moisture retention was obtained using a low pressure ceramic plate extractor; readings at 0.8 atmospheres tension (12p.s.i.) and at 0.1 atmospheres were secured. The pH values were determined by mixing 10 grams of fresh soil and 25 ml of distilled water; readings were taken one and three hours after the mixing of the soil and the water. Soil nitrate content was determined following the phenoldisulphonic acid method (Metson, 1956).

Qualitative Studies of Pigments

The fresh leaves were diced and placed into 99% MeOH and 1% HCl in the dark for 24 hours. Only mature basal leaves were used during the study. The plant material was separated from the solvent and secondary compounds by filtration through Whatman No. 1 filter paper. Two hundred micro-liters of this extract was spotted onto either thin-layer plates or Whatman No. 3 MM chromatography paper (46 × 57 cm sheets). Due to the fact that better separations were obtained with the paper technique the majority of the work was done in this way. The chromatograms were developed (descending) using tertiary butyl alcohol, acetic acid, and water (3:1:1) in the first direction. Caution was exercised to insure that fresh solvent was utilized since the above solvent undergoes esterification reactions rapidly. After thorough drying, the chromatograms were again placed in the chromatocab and developed in the second dimension with 15% acetic acid and water. All the chromatography was done in an air-conditioned, dark room. The temperature was maintained as close to 21° C as possible.

The compounds were tentatively identified by their characteristics under both short-wave and long-wave ultra-

violet light, and by their behavior in the presence of ammonia vapor. Certain phenolic compounds (whitish or bluish in UV) and certain flavonoids (dark or yellowish in UV) appeared in all populations studied while other compounds appeared only off and on.

Quantitative Studies of Anthocyanins

The anthocyanin production studies were completed using leaf-discs from each plant. These were punched from the mature basal leaves with a cork borer (#6) and grown for seven days on a 0.1 M sucrose solution under constant light, at 20° C. The discs were sliced and extracted in a 1% HCl solution for a week on a shaker at approximately 6° C. The amount of anthocyanin was determined colorimetrically using the method of Thiman and Edmonson (1949).

RESULTS

A. Soil Analysis. The results of the soil analysis can be seen in table 1. Although the area traversed is one of varied soils, including some that are rich in silts and clays, all the populations sampled, regardless of species, grew in sandy or sandy-loam soils, with a neutral or more commonly acid pH, low organic matter and low nitrate concentration, although there was considerable variation in this last character. The uniformity of the soil type cannot be assigned to chance and must indicate a preference for this type of soil by the species sampled.

B. Secondary Compounds. Although there was variation in the kind and number of compounds present, in general there was no significant variation that could be correlated between populations. There was a great deal more physiological variation due to development of the plant and environmental variation within the experimental plot than variation due to genetical causes.

Table 2 summarizes the results of the analysis for all the populations investigated. Of the 25 compounds that were evident on the chromatographs, 6 were present in all 83 plants that were analyzed, 10 compounds were present in over 60 of the analyzed plants and 9 compounds were

truly variable. That is they were absent from entire populations and when present in a population often only some plants would show them. No compound was species specific.

Tests were run on both replicates of a clone, and in addition the same plants were tested at different times of the year. The results are summarized in table 3. It can be seen that the variations are relatively great. Still greater differences can be obtained if plants are grown in the greenhouse. When this is done, certain spots fail to show up on the chromatogram. A further source of variation is the technique itself. If a larger or lesser amount of extract is used, the number of spots can be sometimes varied accordingly.

C. *Anthocyanin Production.* The quantitative studies were restricted to measuring the total amount of anthocyanin that the species were capable of producing. The anthocyanin was identified as cyanidin. The object was to see whether (1) different species and populations varied as to the amount of anthocyanin they can produce, and (2) the variations were species specific or if they could be correlated with environmental factors. Preliminary studies (Solbrig, 1966) indicated that there were correlations between altitude above sea level and latitude where the populations grew and that there were also variations between species as to their anthocyanin production.

The results of the present study are summarized in table 4. It can be seen that indeed there are variations between populations and that they are not species specific. There is appreciable difference that can be ascribed to site. It should be remembered, however, that although there are differences in elevation between sites, all the populations grew at about the same latitude.

DISCUSSION

Uniform garden studies are designed to eliminate environmental differences between localities in the shaping of the phenotype. Any differences between phenotypes growing in a uniform environment can therefore be ascribed to genetic differences. It is conceivable, however, that dissimilar

Table 1. Analysis of 24 soil samples.

Pop. No.	Nitrate N_2.ppm/wt of fresh soil	Moisture % a-d soil	Moisture retained at 0.1 atmos. press. % o-d soil	Moisture retained at 0.8 atmos. press. % o-d soil	Dry loss on ignition % a-a soil	> 2 mm. % a-d soil	Coarse sand % a-d soil	Fine sand % a-d soil
426	264.9	4.0	67.9	48.1	21.8	3.9	28.0	26.8
427	89.35	1.8	47.8	26.9	13.8	3.2	25.2	22.6
428	111.6	1.4	24.0	13.9	10.8	25.8	71.8	11.4
430	99.2	2.2	44.2	16.1	6.6	2.0	25.1	29.5
431	5.875	1.5	40.9	19.5	6.4	7.3	28.8	32.7
432	41.6	0.8	26.9	9.6	6.2	15.1	54.0	20.2
433	31.54	1.6	48.0	29.2	12.0	9.6	23.8	13.8
434	2.3	—	—	—	—	—	—	—
435	80.0	—	—	—	—	—	—	—
436	17.6	1.4	16.9	8.6	5.0	31.8	55.4	20.6
439	79.0	2.2	40.6	25.9	8.9	19.5	29.4	15.6
440	14.75	1.2	17.6	8.4	3.7	36.6	62.0	13.4
441	212.65	1.4	41.3	23.6	11.8	32.6	45.2	10.4
442	227.4	0.8	33.6	22.9	8.2	8.9	39.0	25.8
445	140.76	2.6	34.0	18.2	3.7	14.9	22.5	25.1
444	49.8	1.4	34.5	20.4	8.0	18.7	27.7	21.7
445	80.5	0.8	37.9	19.7	7.6	52.6	22.9	20.1
446	20.0	—	—	—	—	—	—	—
447	50.6	1.2	37.6	22.1	8.4	27.0	19.7	16.7
448	45.6	2.2	40.9	29.6	9.3	8.1	5.3	9.5
449	41.65	1.4	44.3	24.2	8.8	33.8	16.1	14.3
450	89.225	—	—	—	—	—	—	—
451	34.0	—	—	—	—	—	—	—
452	35.5	0.8	30.2	16.8	9.0	26.8	37.0	15.0
	X	1.616	37.32	2.125	8.947	19.91	33.63	19.22
	s^2	0.6094	137.95	83.43	16.86	189.29	289.79	44.56
	s	0.7806	11.745	9.134	4.106	13.76	17.023	6.675

Total sand % a-d soil	Silt % a-d sand	Clay % a-d soil	pH	Color Hue (Chroma Value) Munsell Chart	Soil type
54.8	36.8	7.2	5.15	10 Yr 2/2	Sandy loam/loam
47.8	42.0	10.2	4.45	10 Yr 4/2	Loam
83.2	11.0	5.8	4.72	2.5 Yr 4/2	Loamy sand
54.6	37.2	8.2	5.15	10 Yr 4/2	Sandy loam
61.5	27.0	11.2	5.72	2.5 Yr 5/2	Sandy loam
74.2	17.6	8.2	7.20	10 Yr 1/2	Sandy loam
37.6	45.8	1.66	6.20	10 Yr 5/2	Loam
—	—	—	6.43	5 Yr 4/3	—
—	—	—	7.37	2.5 Yr 6/2	—
76.0	14.8	9.2	7.21	5 Yr 5/2	Sandy/sandy loam
45.0	39.8	15.2	5.46	5 Yr 4/2	Loam
75.4	12.8	11.8	7.05	5 Yr 5/2	Sandy loam
55.6	30.2	14.2	5.80	7.5 Yr 4/2	Sandy loam
64.8	26.0	9.2	4.78	10 Yr 3/3	Sandy loam
47.6	39.6	12.8	6.92	10 Yr 3/1	Loam
49.4	29.0	21.6	6.89	10 Yr 4/3	Loam
43.0	39.8	17.2	5.82	5 Yr 4/2	Loam
—	—	—	6.58	10 Yr 3/1	—
36.4	40.4	23.2	6.50	10 Yr 5/2	Loam/clay/loam
14.8	46.8	29.2	5.52	7.5 Yr 4/2	Clay loam
30.4	46.4	23.2	7.11	10 Yr 3/2	Loam
—	—	—	5.01	10 Yr 3/2	—
—	—	—	5.54	10 Yr 6/2	—
52.0	31.8	16.2	6.38	10 Yr 5/2	Loam/sandy loam
52.85	32.36	14.23	6.04		
296.26	133.37	40.88	0.805		
17.21	11.549	6.394	0.8972		

Table 2

Summary of chromatographic analysis

Pop.	Number Tested	Spot No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
427	(8)	+	+	+	?	+	+	+	+	+	?	?	+	+	+	?	?	+	+	+	?	+	?	?	?	?
430	(4)	+	+	+	+	+	+	+	+	+	+	?	+	+	+	?	?	+	+	+	?	?	+	?	?	?
431	(9)	+	?	+	+	+	?	+	+	?	?	?	?	+	+	?	?	?	+	+	?	?	?	?	?	?
432	(8)	+	+	+	?	+	+	+	+	+	?	?	+	+	+	?	+	?	+	+	?	+	+	?	?	?
433	(8)	+	+	+	+	+	+	+	+	+	?	0	?	+	+	?	?	+	+	+	?	+	+	0	?	?
434	(8)	+	+	+	?	+	+	+	+	+	?	?	+	+	+	?	?	+	+	+	?	?	?	?	+	?
435	(3)	+	+	+	+	+	+	+	+	+	0	?	0	+	+	0	0	+	+	+	+	+	+	0	?	+
439	(8)	+	+	+	+	+	+	+	+	+	?	?	+	?	+	+	?	+	+	+	?	?	+	?	+	?
440	(7)	?	+	+	+	+	+	+	+	?	?	?	+	?	+	+	?	+	+	+	?	?	?	?	?	0
441	(1)	+	+	+	+	+	+	+	+	+	0	0	+	0	+	+	0	+	+	+	0	0	+	0	+	+
442	(2)	+	+	+	+	+	+	+	+	0	0	0	+	?	+	+	?	+	+	+	0	?	?	?	?	?
445	(1)	+	+	+	+	0	+	+	+	+	+	0	+	+	+	0	+	+	+	+	0	+	0	0	+	0
446	(2)	+	+	+	+	+	+	+	+	+	?	+	+	+	+	+	?	+	+	+	?	?	?	?	0	0
447	(5)	+	+	+	?	+	+	+	+	+	+	?	+	+	+	?	?	+	+	+	?	+	?	?	?	?
448	(2)	+	+	+	?	+	+	+	+	+	0	0	0	?	+	0	+	0	+	+	0	?	0	+	+	0
449	(1)	+	+	+	+	+	+	+	+	0	0	0	+	+	+	+	+	+	+	+	0	0	+	0	0	0
450	(3)	+	+	+	+	+	+	+	+	0	0	0	+	+	+	+	?	+	+	+	0	0	?	0	?	?
452	(2)	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	0	+	+	+	0	?	+	0	+	+
454	(2)	+	+	+	+	?	+	+	+	+	+	0	+	+	+	+	0	+	+	+	+	+	?	?	?	0
		I	I	P	I	I	I	P	P	I	V	V	I	I	P	I	V	I	P	P	V	V	V	V	V	V

\+ all plants of the population contained the compound
? some plants of the population did and others did not contain the compound
0 no plants appeared to have the compound
I over 60 of the 83 plants tested showed the compound
P all 83 plants showed the compound
V variable compound

TABLE 3

Summary of temporal variation in leaf pigments

Pop. & Plant	Date Run	Spot No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
427-9	8/6/68	+	+	+	0	+	+	+	+	+	0	+	+	+	+	0	0	+	+	+	+	+	+	+	+	+
427-9	9/12/68	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	+	+	0	+	0
432-3 Row 15	8/11/68	+	+	+	0	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	0	+	+
432-3 Row 16	8/11/68	+	+	+	0	+	+	+	+	+	+	0	+	+	+	0	+	+	+	+	+	+	+	0	+	+
432-4 Row 15	8/11/68	+	+	+	0	+	+	+	+	+	+	0	+	+	+	0	+	+	+	+	+	+	+	+	+	+
432-4 Row 16*	8/11/68	+	+	+	+	+	+	+	+	+	+	0	+	+	+	0	+	+	+	+	+	+	+	0	+	0
432-4 Row 16*	8/11/68	+	+	+	0	+	+	+	+	+	+	0	+	+	+	0	+	+	+	+	0	+	+	0	+	+
439-4	8/1/68	+	+	+	+	+	+	+	+	+	0	0	+	0	+	+	0	+	+	+	0	0	+	0	+	+
439-4	10/13/68	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	+	+	+	+	0

*Different leaves from the same plant

TABLE 4

Total Anthocyanins produced by 10 leaf discs

Pop.	Species	Col. Site	Antho. ave. value*
426	cordifolius	(1)	138
428	undulatus	(3)	124
429	cordifolius	(4)	352
430	cordifolius	(5)	129
431	cordifolius	(6)	59
433	cordifolius	(8)	141
434	cordifolius	(9)	148
435	ciliolatus	(9)	140
436	ciliolatus	(9)	62
444	lowreianus	(14)	150
447	cordifolius	(16)	55
448	cordifolius	(17)	98
449	cordifolius	(18)	169
450	cordifolius	(19)	93
451	cordifolius	(19)	65
454	cordifolius	(20)	169

*Readings in Klett units using #54 filter and standardized for volume.

genotypes will react to the same environment by producing similar phenotypes, the well known phenomenon of canalization. This problem to a certain degree puts into question some of the conclusions arrived at in any transplant experiment.

The most striking feature in this study is the uniformity of the populations, considering that we are dealing with four species and three levels of ploidy (9, 18, 36). All plants in their native environment grew in very similar soils. This indicates a definite preference by these species for loose sandy soils, a fact not previously established experimentally.

More interesting, however, from a taxonomic point of view are the studies on the secondary compounds. The seasonal and environmental variation found should be a fair warning to those attempting to use similar methods of chromatography of secondary compounds for taxonomic purposes using random field samples or herbarium samples. At least in the heterophylli *Aster* secondary compounds vary greatly during the growing season, and are also affected by the particular environment of the plant. The environment affects both the number as well as the intensity of spots produced.

It appears that during the evolution of the heterophylli *Aster* little or no differentiation has occurred in soil preference, at least in the N.E. United States. There seems to have been little change in the alcohol soluble secondary compounds also. There have been no species specific changes in the amount of anthocyanin that the various species produce.

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Collection Data

Sites

1. Mass., on Rte. 111. 4.7 miles N. of Jct with Rte. 110 Harvard Township. 67-426 *Aster cordifolius* (*Solbrig* 4046); *Aster cordifolius* (*Solbrig* 4047).
2. Mass., Hwy 31, 1 mile south of Hwy 12. Plants growing under oak, beech, and maple. 67-428 *Aster undulatus* (*Solbrig* 4048).
3. Mass., 5 miles east of Hardwick, under maple forest. 67-429. *Aster cordifolius* (*Solbrig* 4049).
4. Mass., Jct of 9 and 202. Growing under a maple-oak forest. 67-430. *Aster cordifolius* (*Solbrig* 4050).
5. Mass. Hwy 9, 1 mile east of Williamsburg, under an oak-maple forest. 67-431. *Aster cordifolius* (*Solbrig* 4051).
6. Mass., Hwy 9, 1.9 miles east of Windsor. Growing under a mixed hardwood-softwood forest, mostly at the more illuminated edges. 64-432. *Aster cordifolius* (*Solbrig* 4052).
7. Mass., Hwy 20, 8.1 miles west of Pittsfield, at the edge of a maple-oak forest. 67-433. *Aster cordifolius* (*Solbrig* 4053).

8. New York, Rte. 23, 1.2 miles east of East Windham. Plants growing in mixed maple, elm, and oak forest. 67-434. *Aster cordifolius* (*Solbrig* 4054); 67-435. *Aster ciliolatus* Lindl. (*Solbrig* 4055); 67-436. *Aster ciliolatus* Lindl. (*Solbrig* 4056); 67-437. *Aster acuminatus* Lindl. (*Solbrig* 4057); 67-438 *Aster acuminatus* Lindl. (*Solbrig* 4058).
9. New York, Hwy 10, 4.6 miles south of Stamford. Growing on an embankment under a few maples at the edge of a field. 67-439. *Aster cordifolius* L. (*Solbrig* 4059).
10. New York, Hwy 28, 6.1 miles east of the Jct with 7B. 67-440. *Aster cordifolius* (*Solbrig* 4060).
11. New York, on Hwy 7, 1.2 miles south of Riverside. Growing in a weedy area with goldenrods, brambles, rhus, etc. 67-441. *Aster cordifolius* (*Solbrig* 4061).
12. New York, Hwy 17, 8.7 miles east of Oswego. (Jct Hwy 283) Growing in a weedy area under a few maple trees. 67-442. *Aster cordifolius* (*Solbrig* 4062).
13. New York, Hwy 17 east of Elmira (3.2 miles east of Chemniz) Growing on the edge of a disturbed woods. 67-443. *Aster cordifolius.* (*Solbrig* 4063); 67-444. *Aster lowreianus* (*Solbrig* 4064); 67-445. *Aster laevis* (*Solbrig* 4065).
14. New York, Hwy 17, 1.6 miles east of Addison. Growing at the edge of a beech-oak forest. 67-446. *Aster cordifolius* (*Solbrig* 4066).
15. New York, west outskirts of Wellsville. Growing under maples and *Crataegus.* 67-447. *Aster cordifolius* (*Solbrig* 4067).
16. New York, 3 miles south of the village of Whitehouse. Growing in woodland with a border of mixed maple and oak with many introduced shrubs. 67-448. *Aster cordifolius* (*Solbrig* 4068).
17. Pennsylvania, on Hwy 770, 4.3 miles east of the Jct with 59. Growing in a secondary forest of oak, maple, beech, and hickory. 67-449. *Aster cordifolius* (*Solbrig* 4069).
18. Pennsylvania, Hwy 27, 2 miles west of Pittsfield. Growing at the edge of an open field, in a ditch, and at the forest edge respectively. 67-450. *Aster cordifolius* L. (*Solbrig* 4070); 67-451. *Aster sagitifolius* (*Solbrig* 4071); 67-455. *Aster acuminatus* (*Solbrig* 4073).
19. Pennsylvania, Hwy 77, 1 mile south-west of Jct Hwy 8. Growing in small woods at the edge of the road. 67-454. *Aster cordifolius* (*Solbrig* 4074).

BIOSYSTEMATICS OF SETCREASEA BREVIFOLIA

S. A. Faruqi[1] and K. L. Mehra[2]

Setcreasea brevifolia (Torr.) Schum. & Sydow is a highly polymorphic and poorly understood species distributed in northern Mexico and southern Texas. Rose (1899, 1903, 1911) and Matuda (1955) included several taxa as synonyms of *S. brevifolia*, without indicating their similarities or differences. The similarities between certain taxa are so strong that for almost sixty years *S. ovata* (Coulter) Faruqi, Celarier & Mehra (Syn. *Tradescantia leiandra* var. *ovata* Coulter, Contr. U. S. Nat. Herb., 1: 50. 1890) was regarded as a synonym of *S. brevifolia* (Torr.) Schum. & Sydow. Floral morphology and crossing data suggested that *S. ovata* Faruqi et al. is related to the *S. pallida* Rose — *S. purpurea* Boom group and that it is not in the direct evolutionary line of *S. brevifolia* (Faruqi et al., 1962). Another taxon, *Tradescantia speciosa* Buckley, considered by Rose (1899, 1911) and Matuda (1955) as a synonym of *S. brevifolia* and treated as *S. buckleyi* Johnst. (Johnston, 1944) needs taxonomic consideration since no barriers to crossability exist between these taxa and the distinction between them is ecological and morphological (Faruqi and Mehra, 1966). Furthermore, a few other taxa have never been mentioned or included within *S. brevifolia* in spite of their resemblance to this species. One such taxon was collected from the Ottine Swamp of Gonzales Co. in Texas. Its plants were very small, hardly six inches tall and with very narrow leaves. A similar plant from an unknown locality was present in our living collection and it was crossed with *S. brevifolia*. The F_1 hybrid resembled other plants from our living culture and herbarium collections. One of the herbarium sheets resembling this hybrid was annotated with a name by Bartell, but it was never pub-

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lished. It is important to note that all of the foresaid taxa except *S. ovata* are characterized by narrow connectives and pubescent ovary. Whether these taxa should be included within *S. brevifolia* or should be treated as different species needs consideration. Besides, the origin of these variations should also be considered. Biosystematic studies were, therefore, undertaken on living and herbarium specimens and four varieties were recognized within *S. brevifolia* (Torr.) Schum. & Sydow. The results are reported in this paper.

Setcreasea brevifolia (Torr.) Schum. & Sydow, in Just, Bot. Jahrb. 27(1): 452. 1899 (1901).

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Zebrina (?) *leiandra* Clark, in DC. Monograph. Phan. 3: 318. 1881.
Tradescantia leiandra Wats., Proc. Amer. Acad. 18: 167. 1883.
Tradescantia brevifolia Rose, Contr. Nat. Herb. 3: 323, *pl. 16*. 1895.
Treleasea brevifolia Rose, Contr. Nat. Herb. 5: 207. 1899.
Neotreleasea brevifolia Rose, Contr. Nat. Herb. 8: 6. 1903.

Stem 8-30 cm in height; sepals 3; petals 3; stamens 6, epipetalous, connectives thick and narrow; and ovary pubescent.

Four varieties were recognized within *S. brevifolia*. The stem is unbranched and the leaves are 3-4 cm long in var. 1- *nanella*. The stems are branched and the lengths of the leaves are 5-6 cm in var. 2- *pulchella*, 7-10 cm in var. 3- *brevifolia* and 10-13 cm in var. 4- *buckleyi*.

1. *S. brevifolia* var. *nanella* Faruqi et Mehra, var. nov.

Caule non ramoso, erecto, 10-20 cm alto; folia lanceolata vel elliptico — lanceolata, viridia, 3-4 cm longa, 1-2 cm lata.

HOLOTYPE: U.S.A. TEXAS, GONZALES CO., Ottine Swamp, *Cory* 14581 (GH). MEXICO: D.F. MEXICO: Raynosa, *Runyon* 20 (US); *Clover* 1932, cultivated (MICH).

Cultivated: *Setcreasea* Taxon-1 (Mehra et al., 1961).

Faruqi and Mehra (1967) reported that some kind of genetic barrier seems to exist between the varieties *brevifolia* and *nanella* since only three hybrids could be obtained from forty pollinations attempted between them. Both varieties have 24 somatic chromosomes and exhibit similar cytological irregularities during meiosis (Mehra et al., 1961; Faruqi and Mehra, 1967). Binomial was a good fit to the distribution of multivalents during metaphase I of microsporogenesis in the var. *brevifolia*, indicating that all six groups of four chromosomes had an equal chance of pairing as a quadrivalent (Mehra et al., 1969). In the var. *nanella*, the binomial was not a good fit to the distribution of multivalents, indicating differential pairing behaviour of the chromosomes during metaphase I of microsporogenesis (Mehra et al., 1969). Thus, chromosomal differentiation seems to have taken place in the evolution of the var. *nanella*.

2. *S. brevifolia* var. *pulchella* Faruqi & Mehra, var. nov.

Caule ramoso, delicatulo, prostrato vel subascendente, 15-25 cm longo; folia lanceolata, elliptico-ovata, viridia, 5-6 cm longa, 1.5 cm lata.

HOLOTYPE: MEXICO: TAMAULIPAS, Cerro El Palmer S. of Cruillas, *Clover* 13763 (MICH). D.F. MEXICO: *Bartel* 13763 (MICH); *Clover* 14920; cultivated number and the name of the collector not given (MICH). U.S.A.: TEXAS: HIDALGO CO., *Lundell & Lundell* 9944 (US); *Cory* 20465 (GH); Corpus Christi, *Mcally* 1894 (GH).

Faruqi and Mehra (1966, 1967) reported that hybrids between varieties *brevifolia* and *nanella* resemble an undescribed taxon (now called var. *pulchella*) represented in living culture and herbarium specimens. While the types of chromosomal irregularities were similar in the parents and hybrids, the binomial was not a good fit to the distribution of multivalents in one of the three hybrids (Mehra et al., 1969). It would suggest differential pairing behaviour of chromosomes in this hybrid. The survival of such chromo-

some types with structural hybridity is enhanced owing to the vegetative mode of reproduction.

3. *S. brevifolia* var. *brevifolia*

Syn. *Tradescantia leiandra* var. *brevifolia*. Torr., in Emory U. S. and Mex. Bound. Survey 225. 1859.

Stem branched, prostrate or slightly ascending, about 30 cm long; leaves ovate, purple-green, 7-10 cm long and 2-3 cm wide.

HOLOTYPE: mountains near the mouth of the Pecos River, Oct. 19, 1852, *Bigelow* 1500 a (NY). MEXICO: Victoria, *Palmer* 601447 (F). U.S.A. TEXAS: Corpus Christi, *Rose* 1896 (GH), 839905 (GH); *Nealy*, 07.457 (F, GH, US); *Heller* 1427 (GH, MO, US); *Mulley* 1895 (US). CULTIVATED: *Norton* 1737019 (MO); *Rose*, July 21, 1896 (GH, US).

The type specimen is deposited in the N.Y. Botanical Garden Herbarium, but it is not in a condition that its floral morphology could be worked out. The type description mentions a pubescent ovary, but the sketch of the floral parts on the herbarium sheet shows glabrous ovary. Since there is no way to find out the actual position, the words from the description are taken as correct.

4. *S. brevifolia* var. *buckleyi* (Johnst.) Faruqi & Mehra, comb. nov.

Syn. *Tradescantia speciosa* Buckl., Proc. Acad. Phila. 1862: 9. 1863, non L.f. or H.B.K.

Setcreasea buckleyi Johnst., Jour. Arn. Arb. 25: 54. 1944.

HOLOTYPE: U.S.A. TEXAS, Corpus Christi, *Buckley*, number not given on the sheet (Acad. of Natural Sciences, Philadelphia). MEXICO: TAMAULIPAS, near Santa Terasa, *Johnston* 5491 (UT); north of Almada, *Johnston* 5707 B (UT); *Herman* 13763; New Victoria, collector not known (UT).

Johnston (1944) changed *Tradescantia speciosa* Buckl. to *S. buckleyi* and stated, "*S. brevifolia* is found from the Chisos and Davis Mts. to the lower Pecos River, and mor-

phologically it is a low plant with coarse rhizomes; whereas *S. buckleyi* is a plant of the coastal region of Texas which has a paler corolla and a loosely branched, elongated, trailing stem."

The only difference between this variety and var. *brevifolia* is its larger more or less elliptic leaves, 10-13 cm long and 2.8-4.2 cm wide; longer internodes and many branches from the base forming mounds in its natural habitat. Under greenhouse conditions, however, the plants usually referred to as *brevifolia* do possess leaves as big as var. *buckleyi* and it is very difficult to differentiate between these varieties (Faruqi and Mehra, 1966). The inland populations of var. *brevifolia* exhibit shortening of leaves towards its northern area of distribution as compared to the southern area. This, however, does not seem to be the case with coastal plants of var. *buckleyi* (Faruqi and Mehra, 1966). Under natural conditions var. *buckleyi* is certainly taller than var. *brevifolia*. Under greenhouse conditions it grows no taller than var. *brevifolia* and is slow growing and late flowering.

Under laboratory conditions varieties *brevifolia* and *buckleyi* could be crossed fairly easily and the seeds were produced when either one was used as the female parent. Thus, there is no genetic barrier between these varieties and the distinction between them is ecological and morphological. But, one specimen (*Johnston* 5491) from north Texas resembled var. *brevifolia* in a few characters and var. *buckleyi* in others, indicating some gene exchange between these varieties. Since these taxa demonstrate some degree of morphological differences and have different ecological preferences, they only deserve varietal status.

Mexico is the center of origin of the genus *Setcreasea*, and it is here that all of the primitive species such as *S. tumida* Rose, *S. australis* Rose, *S. purpurea* Boom and *S. pallida* Rose are distributed (Faruqi and Mehra, 1966). Primitive species of this genus have leaves larger than those of the advanced ones; by the same token a tendency towards the shortening of the shoot is also present in the advanced species. Thus, the leaves are larger and the stems are longer

in the populations of *S. brevifolia* distributed in the south (i.e., northern Mexico and southern Texas) than those in the populations distributed in the north (i.e., mid Texas). Thus, the var. *nanella* seems to have originated from *S. brevifolia* var. *brevifolia* in the process of its northward migration followed by ecological adaptation. It seems that in the origin of variations in *S. brevifolia* ecological adaptation has played an important role when migration from warm climate, where growing seasons are long, to cold climate, where the seasons for its growth are short, took place. An absence of this type of variation from south to north in the coastal population (var. *buckleyi*) seems to be correlated with the mild climate of the coastal areas. In fact, the leaves became longer and broader in the coastal area. Experimental hybrids between varieties *brevifolia* and *nanella* resembled var. *pulchella* and their leaf lengths were intermediate between those of their parents.

In *Setcreasea brevifolia*, the chromosome races with somatic chromosome numbers, 12 (Richardson, 1935), 23 (Celarier, 1955; Mehra et al., 1961), 24 (Darlington, 1929; Richardson, 1935, Mehra et al., 1961), 25 (Bose, 1962) and 36 (Anderson and Sax, 1936) have been reported. The materials of *S. brevifolia* used in this study had 23 (var. *brevifolia*) and 24 (vars. *nanella*, *pulchella* and *buckleyi*) somatic chromosomes. The previous reports on the chromosome morphology indicated that changes in the chromosome structure are taking place in this species (Darlington, 1929; Richardson, 1935). The chromosome and genetic differentiation is not uniform in all six sets of four chromosomes in the var. *nanella* (Mehra et al., 1969). It is assumed that *S. brevifolia* is in an active stage of evolution, in which euploidy, aneuploidy, structural hybridity, and hybridization between its varieties seem to be playing a major part. The vegetative mode of reproduction and perennial habit seem to be responsible for the maintenance of varieties within this species. Through the forces of selection some of these varieties are fixed in certain ecological niches, and wherever possible self-incompatibility ensures interpopula-

tion gene exchange through natural crossing. The range of morphological variation encountered is due to these factors, which in combination with each other produce an effect similar to that of facultative apomicts, exhibiting restricted gene exchange (Baker, 1953, 1959; Celarier et al., 1958; Faruqi, 1963; Faruqi and Mehra, 1968).

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NEW AND OVERLOOKED SPECIES OF THE VIRGINIA FLORA. — Recent field and herbarium studies have turned up the following species which are apparently new to the state or were overlooked by Massey in his "Virginia Flora," 1961. Specimens are deposited in the Longwood College Herbarium; duplicates are in herbaria indicated by symbols after collecting numbers.

Najas minor Allioni. James River near Brandon, Prince George Co. *Svenson & Harvill* 17012. An introduction from the Old World which is local in the eastern states (Meriläinen, Rhodora **70**: 169, 1968). Radford, Ahles and Bell list it for Wake Co., North Carolina in their "Manual of the Vascular Flora of the Carolinas," 1968.

Panicum longifolium Torrey. Boggy marsh north of Burgess Station, Dinwiddie Co.; sphagnous bog northwest of Dahlia, Greensville Co. *Harvill* 20304 & 17603. Although ranging on the coastal plain from Nova Scotia to Florida and Texas, thence north to Kentucky, it appears to be rare in Virginia.

Scirpus ancistrochaetus Schuyler. High-elevation pond on the southern edge of Alleghany Co. *Harvill* 14559 (PH). Determined by Dr. A. E. Schuyler who states in his "Leafy Species of Scirpus," 312, 1967, that it is known from only a few localities in Vermont, Massachusetts, New York and Pennsylvania. This is the southernmost record for the plant.

Juncus validus Coville. In white sand of the *Stipulicida* area (Rhodora **69**: 777, 1967) in Isle of Wight Co. *Harvill* 17062 (US). Identity confirmed by Dr. F. J. Hermann. A northern extension of the eastern arm of its distributional arc which extends to Florida and Texas, thence north to Oklahoma and southwestern Missouri. The nearest known station is in Dare Co., North Carolina mapped by Radford, Ahles and Bell in their "Manual," 279, 1968.

Arenaria patula Michaux. In shallow soil on limestone flatrocks in The Cedars, Lee Co. *Harvill* 18530. An eastward extension for the species which ranges from southern Ohio to Kansas, Texas, Alabama and Tennessee.

Silene gallica L. Sandy slope above a sphagnous bog northwest of Dahlia, Greensville Co. *Harvill* 21311. Collected by Barbara J. Harvill. An adventive from Europe which is very local in the southeastern states (Radford, Ahles and Bell, "Manual," 447, 1968).

Fraxinus quadrangulata Michaux. Limestone slope near Hilton, Scott Co. *Harvill* 17778. An eastward extension for the blue ash which ranges from Ontario to Oklahoma, Alabama and Kentucky.

Mazus japonicus (Thunberg) Kuntze. Bank of a stream near Richmond, Henrico Co. Specimen sent to me by Dr. John C. Strickland of the University of Richmond. Naturalized from eastern Asia and very local in the southeastern states (Radford, Ahles and Bell, "Manual," 942, 1968).

Bellis perennis L. Weed on the campus of Randolph-Macon College, Hanover Co. Specimen sent to me by Dr. Leonard O. Morrow of Randolph-Macon College. A southeastward range extension of the introduced European plant which is rare in the southeastern states. Mapped only for Mitchell and Yancy counties, North Carolina by Radford, Ahles and Bell in their "Manual," 1071, 1968.

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LISTERA OVATA (L.) R. BR. IN THE BRUCE PENINSULA, ONTARIO. — On July 11, 1968, Miss Bessie Plunkett of Port Arthur, Ontario with the senior author and a group from the Federation of Ontario Naturalists summer camp discovered a colony of about 15 orchids near the village of Red Bay in the Bruce Peninsula, Ontario. The plants were recognized as belonging to the genus *Listera*, but were obviously not one of the five species found in northeastern North America.

A single specimen was collected on July 17, 1968 by J. F. Alex of the University of Guelph with A. G. Thomas and C. R. Skelton. (*J. F. Alex et al* 3090 (OAC) Ontario, Bruce County, Albemarle Township, Red Bay P.O. 17 July, 1968). Alex tentatively identified the specimen as *Listera ovata* (L.) R. Br. and forwarded it to the Plant Research Institute of the Department of Agriculture, Ottawa. It was examined and compared with European material by C. Frankton, B. Boivin and E. W. Greenwood who confirmed Alex's identification.

F. W. Case, Jr. of Saginaw, Michigan and L. A. Garay of the Botanical Museum of Harvard University examined colored photographs and drawings of the Red Bay plants and suggested that they represented *L. ovata*.

The orchids were found in a partly open, recently cleared area on the borders of a cedar (*Thuja occidentalis* L.) swamp. The soil is a sandy gravel covered with a few inches of humus and overlying dolomite. One of the plants was 60 cm in height and bore 52 blooms; six were over 40 cm high and the remainder about 30 cm. Approximately 20 plants reappeared in the same location in June, 1969 and several more specimens were discovered under eastern white cedars and black ash about 500 yards east of the original find.

The field notes by J. F. Alex on the specimen label read, in part: "about 15 plants scattered through 20 m area recently cleared of brush, deadfall, etc. under cedar with ash, poplar and birch. Soil moderately drained organic sand. Plants ranged in height 38-61 cm".

Butcher (1961) says that "it is a common plant of grassland and woods on basic soils throughout the British Isles". Summerhayes (1951) states, ". . . . the common twayblade is probably commoner and more widely distributed in this country (Britain) than any other kind of orchid". He gives its range as "throughout Europe from northern Scandinavia and Russia southwards to the Mediterranean, . . . while eastwards it extends through Siberia to the region of Lake Baikal and through Asia Minor to the western end of the Himalayan Range".

We are not aware of any previous occurrence of this twayblade having been recorded from North America and can only guess as to how it may have found its way to the Bruce Peninsula. A preliminary note on this finding has been published by Elliott (1969).

The authors wish to thank J. F. Alex and others mentioned for their assistance.

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ZONATION OF BRYOPHYTES IN THE HEADWATERS OF A NEW HAMPSHIRE STREAM

JANICE M. GLIME

A vertical zonation of bryophytes on the rocks of the Fox Pond inlet in Plymouth, N.H., is apparent. Here, *Fontinalis novae-angliae* covers the submerged portion while the exposed rock grades from *Plagiochila asplenioides* just above *F. novae-angliae* to Hypnaceae and *Mnium* on the uppermost portions. This gradation suggests the possibilities of moisture, light, or temperature gradients as causal factors, while submersion in high water seasons may also play a part.

Also apparent in this stream is the dominance of *Scapania undulata* at upstream locations and a shift to *Fontinalis novae-angliae* and *Plagiochila asplenioides* farther downstream.

During the late winter of 1969, the inlet of Fox Pond. Plymouth, Grafton Co., N.H., was selected as a study stream for two reasons: its proximity to the campus laboratory and its lush growth of bryophytes which could be used for descriptive studies.

To determine the relative abundance of the *Fontinalis* species and the several accompanying liverwort species, random observation stations were chosen and labelled from the source to a selected point downstream. This selected point marks the beginning of a stream drift study area and it seemed desirable to keep the two areas separate. Stations were chosen by placing the numbers 1-10 in a bucket, drawing a number, multiplying that by five, and taking that many paces to the next station. For example, station AA was placed at the most distal spring of the headwaters, and a 7 was drawn, so station BB was 35 paces downstream. Since the same researcher marked the paces each time, the distances between stations are approximately comparable and the procedure is an expedient one. By this

procedure, seventeen stations (AA-QQ) were chosen. Further downstream twelve stations (A-L) had previously been selected by the same procedure, giving a total of 29 stations. A station extends 2.5 m. on each side of the station label, which is painted on a nearby tree.

Observations were made on September 13 and 15, 1969, at each of the 29 stations, the dominant bryophytes were identified and their locations noted from headwater downstream.

The general trend shows a lack of aquatic bryophytes in the extreme headwaters, but it is not far (about 80 m. at the lower end of EE) before *Fontinalis novae-angliae* Sull. appears, along with several species of leafy liverworts. At this point also, *F. antipyretica* Hedw. var. *gigantea* (Sull.) Sull. occurs, one of two locations for the plant in this stream. As soon as submerged rocks appear in the stream, *F. novae-angliae* dominates the water, while *Scapania undulata* (L.) Dum. grows just beneath the surface and on the wet exposed surface of rocks, while higher parts of the rocks exhibit *Plagiochila asplenioides* (L.) Dum. or *S. nemorosa* (L.) Dum. Farther downstream *P. asplenioides* replaces *S. nemorosa* and a clear line of demarcation appears where *P. asplenioides* meets *F. novae-angliae*. It is in this same region that *F. novae-angliae* becomes a dominant ground cover in the stream, blanketing 50-100% of the stream bottom. There is almost no intermingling of *P. asplenioides* and *F. novae-angliae*, and on the date of observation *P. asplenioides* was always out of the water. However, observations during winter and spring of 1969 showed that many areas of *P. asplenioides* were submerged. Farther down stream, especially on the larger rocks which occur there, a 3-layered zonation appears, typically *F. novae-angliae* — *P. asplenioides* — *Mnium* & Hypnaceae, including *Thuidium delicatulum* (Hedw.) BSG. Occasional clumps of *F. dalecarlica* Schimp. ex. BSG occur, but never reach abundance.

Several factors can be important in determining the location of these bryophytes, and the perfectly repetitive zonation pattern of *F. novae-angliae* to *P. asplenioides* in

the last 14 stations is clearly not one of chance. Observations of the conditions surrounding these plants during two extreme seasons (late winter and late summer) indicate that water level at critical times, coupled with summer humidity, may account for the locations. At all stations, *Fontinalis* was wet, although it was not always submerged during September. Furthermore, at no station was any *P. asplenioides* submerged in summer. But the occurrence of *P. asplenioides* under water for a 2-3 week period in the spring is probably one of tolerance, not of requirement, for *P. asplenioides* is known from soil-covered walls and slopes of open mountain woods (Watson, 1963), which are not likely to ever be submerged. On the other hand, its ability to tolerate the scouring effect of snow melted, debris-filled water could be a competitive advantage over the hypnaceous bryophytes of the upper rock surfaces. When I felt the bryophytes, a humidity gradient was apparent between these two zones on the rocks at the selected stations, and *P. asplenioides* was always damp. The Hypnaceae, with their compact, adnate growth form (smooth mat, Gimingham & Birse, 1957), grow on the drier upper portions of the rocks while *P. asplenioides* (tall turf, Gimingham & Birse, 1957) enjoys the greater humidity of the lower areas. Mr. Luna B. Witton, the owner of the property, states that the stream had much more water than usual in 1969, so the moisture stress on the exposed upper parts of the rocks would likely be much greater in other years. Nevertheless, these are only speculations, and it may well be that a temperature gradient is a more important factor, where one would expect the extremes to occur on the higher parts of rocks, while the most moderate temperatures would be in the water. Or, zones could be related to light intensity, or interaction of all these factors, as suggested by Gimingham & Birse (1957) in their study of vertical zones of stream banks.

Further speculation might suggest that the abundance of *Scapania undulata* and *S. nemorosa* upstream and their replacement by *P. asplenioides* downstream could be related to the more stable water level farther upstream. In a pre-

vious study (Glime, 1968), I indicated that *Scapania undulata* grows in Garrett Co., Maryland, on the brink of waterfalls, and in Carbon Co., Pennsylvania, on the water-air interface zones of rocks and boulders. Its areas of occurrence appear to be areas which keep it constantly soaked, while its terrestrial counterpart, *S. nemorosa*, grows high enough on the rocks to be rarely submerged.

Now at least we know that zonations exist, we have several hypotheses to test, and we can proceed to experimental work and detailed data to test these hypotheses.

Voucher specimens are filed in the DePauw University Herbarium, Greencastle, Indiana.

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VERNON BLACK GUM SWAMP

F. R. Fosberg and Terry Blunt

In the hills in the town of Vernon, Vermont, just north of the Massachusetts boundary and just west of the Connecticut River is a small but interesting swamp, featuring a disjunct stand of *Nyssa sylvatica* Marsh., considerably north and inland from the usual distribution of this species. This swamp was very briefly described by H. W. Vogelmann in Vermont Natural Areas — Report 2, March 1969. We visited it on October 5, 1969, and studied it enough to prepare a somewhat fuller description. We also visited the owner, the distinguished architect, Mr. Jacques Delamarre, and suggested to him the desirability of preserving this area so that longer term, more adequate investigations could be carried out, and because it is a unique natural feature in this region.

The swamp lies at an elevation of about 320 m on a small bench on the southwest side of a prominent knob, apparently unnamed. This shelf has a depression of about 2-3 hectares, rimmed by a curved ridge of hard schist up to 10 m high. At the east end is a notch, cut by a small stream that forms the outlet of the swamp. The surrounding area is a mixed *Tsuga canadensis* forest that has been recently severely cut. The ridge is covered by an open mixed forest from which a few hemlocks have been cut, but which has so little soil that trees of large size are scarcely to be expected. *Acer rubrum* L., *Betula papyrifera* Marsh., *Betula alleghaniensis* Britt., *Betula lenta* L., *Tsua canadensis* (L.) Carr. and *Pinus strobus* L. were observed on the ridge with one large old *Fagus grandifolia* Ehrh. just above the level of the swamp. Ericaceous shrubs and dwarf shrubs such as *Kalmia latifolia* L., *Vaccinium angustifolium* Ait., and *Gaultheria procumbens* L. form a sparse shrub layer. A few saplings of *Castanea dentata* (Marsh.) Borkh. and *Fagus grandifolia* Ehrh. are scattered here and there.

The depression, itself, is filled, to the level of the outlet notch, with fallen trees, humus, and *Sphagnum*. A very

irregular closed mixed forest about 5-8 m tall covers the swampy area with the following trees in the main closed layer: *Betula alleghaniensis* Britt., *Nyssa sylvatica* Marsh., *Tsuga canadensis* (L.) Carr., *Picea rubens* Sarg., *Acer rubrum* L.

Scattered emergent trees, up to 25 or 30 m tall, are: *Acer rubrum* L., *Nyssa sylvatica* Marsh., *Tsuga canadensis* (L.) Carr., *Picea rubens* Sarg., In the lower end are some *Pinus strobus* L.

A shrub layer, open, to in places quite dense, includes: *Ilex verticillata* (L.) Gray, *Viburnum cassinoides* L., *Nemopanthus mucronata* (L.) Trel., *Vaccinium corymbosum* L., *Kalmia angustifolia* L. (near the lower end) and near the edges also: *Viburnum alnifolium* Marsh., *Kalmia latifolia* L., *Hammamelis virginiana* L. and *Acer pensylvanicum* L.

The herb layer is closed to open, with a ground surface of litter and *Sphagnum*. It is composed of the following (including dwarf shrubs): *Osmunda cinnamomea* L., *Osmunda regalis* L., *Coptis groenlandica* (Oeder) Fern., *Aralia nudicaulis* L., *Gaultheria hispidula* (L.) Bigel., *Mitchella repens* L., *Vaccinium angustifolium* Ait., *Carex* cf. *rosea* Schkuhr., *Viburnum alnifolium* Marsh., *Lycopodium obscurum*, *Thelypteris dryopteris*, *Uvularia sessilifolia* L., *Aster* cf. *puniceus* L., *Kalmia angustifolia* L., *Gaultheria procumbens* L., *Pteridium aquilinum* (L.) Kuhn, *Quercus rubra* L. (seedling).

The last six listed are principally near the edges and in the lower end with *Pinus strobus* L. *Epigaea repens* L. covered a rootman of a blow-down and was seen rarely in other high spots in the swamp.

The *Nyssa*, with their red autumn coloring, were very conspicuous. They reached 4-6 dm diameter at breast height and 20 m tall, and the large ones were all "stag-headed". The bark on leaning ones was thin and flaky on the upper sides, thick, deeply cleft and ridged on lower sides. There were the large *Nyssa* trees mentioned above, rather widely spaced, others 4-5 m tall, and a few seedlings, but few or no intermediates between these classes.

In addition to the plants seen by us, Vogelmann mentions star flower (*Trientalis borealis* Raf.), wild lily-of-the-valley (*Maianthemum canadense* Desf.), painted trillium (*Trillium undulatum* Willd.), and interrupted fern (*Osmunda claytoniana* L.). He interprets the occurrences of *Nyssa* as a relict from a period of warmer climate. We do not disagree with this, since the species is now abundant only considerably south of this station. He says that a few scattered trees do occur elsewhere in Vermont, as near Burlington, but not such a concentration as here.

It is to be hoped that this interesting pocket may be protected as a nature preserve for the enjoyment and education of future generations of naturalists.

SMITHSONIAN INSTITUTION
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CONNECTICUT RIVER WATERSHED COUNCIL
GREENFIELD, MASS. 01301

RECENT PLANT RECORDS FOR NEBRASKA

ROBERT J. LEMAIRE

Part of my work as the biologist for the Soil Conservation Service in Nebraska includes assisting various groups and individuals throughout the state to establish nature trails. These are essentially botanical trails along which usually only vascular plants are identified and labeled. Among the plants I collected and identified along the more than 50 nature trails in the state were four species which, to my knowledge, have not previously been reported for Nebraska. One additional species was found in a very unusual habitat. Nomenclature for the following five species follows Fernald (1950).

On May 18, 1966, I collected specimens of *Collinsia parviflora* Dougl. in the extreme northwest corner of the state at the Ross Raum ranch in Sioux County, about nine miles northwest of Crawford. This is a rough, ponderosa pine woodland area, part of the "Pine Ridge" in Nebraska. This annual species occurs mainly west of Nebraska. I failed to find the plant again at the same location in the spring of 1968.

On September 10, 1966, I collected specimens of *Leonurus sibiricus* L., at the Riverview Vacation Ranch near Comstock in the Sandhills region. This adventive plant from Eurasia is similar to *L. cardiaca* L., a common naturalized weed in Nebraska. The plants were located along a fence line and in disturbed soil along a dirt road. I have not seen the species elsewhere in the state.

Circaea canadensis Hill, a plant native to northeastern United States, was collected along the wooded bluffs of the Missouri River about five miles south of Nebraska City on June 29, 1966. The woodland along the Missouri River in southeastern Nebraska is the approximate western edge of the eastern deciduous forest type.

In May 1966, I collected a specimen of *Veronica hederaefolia* L. on the College of Agriculture campus of the Uni-

versity of Nebraska in Lincoln. A native of Europe, this species is now reported naturalized in several eastern states at least as far west as Ohio. The specimen was growing as a weed in a Kentucky bluegrass lawn.

The roof of a mid-town Lincoln building is a very unusual location for finding a plant new to Nebraska. Part of the building is only three stories tall and part is six stories. On October 4, 1968, I collected *Cyperus difformis* L. growing abundantly in a "marsh" on the roof of the third floor and as scattered plants in very shallow water (up to 3/4 inch deep) on the sixth floor roof. Evidently natural rainfall and water condensed from air conditioning units maintain suitable growing conditions for this wetland plant on these flat, pebble and asphalt roofs. The "marsh" has been in existence for at least 15 years according to residents of the building. It is not known how long *C. difformis* has been growing here. The standard manuals indicate that this Asian species is adventive only in Virginia and California.

Specimens of these five species have been deposited in the herbarium of the University of Nebraska at Lincoln.

SOIL CONSERVATION SERVICE
134 SOUTH 12TH STREET
LINCOLN, NEBRASKA 68508

LITERATURE CITED

FERNALD, M. S. 1950. Gray's Manual of Botany, 8th ed. American Book Co., New York. 1632 pp.

AN ASSEMBLAGE OF HALOPHYTES IN NORTHERN OHIO: A remarkable group of weedy plants has been discovered on the property of the Morton Salt Company in Rittman, Wayne County, Ohio. In this area are several brine wells and a large pool in which brine is stored prior to processing. Adjacent to these wells grow *Salicornia europaea* L. (glasswort) and *Atriplex argentea* Nutt. (saltbush), both apparently new to the Ohio flora.

Salicornia, of course, is a well-known salt marsh inhabitant. Here at Rittman it forms great orange-red masses of thousands of individuals. The *Atriplex*, a western species of alkaline areas, occurs with the glasswort, but is much less common. Fernald (1950) does not include Ohio in the range of *Salicornia*, but does list *A. argentea* as adventive in Ohio. Neither species is mentioned by Weishaupt (1968), however, and no Ohio herbarium specimens are known to the author. Company officials, unfortunately, could give no information as to when these species first appeared.

Both these species occur in the most disturbed ground around the wells where no other plants grow. An exception is an occasional specimen of *Coriospermum hyssopifolium* L. Along the run-offs from the wells *Cyperus esculentus* L., *Juncus effusus* L., and *Typha angustifolia* L. are common.

It is hoped that a general study of this station can be developed, as this is perhaps an unique ecological situation for Ohio.

All species cited are represented in the herbarium of Kent State University.

Acknowledgements are gratefully given to Dr. B. A. Foote of Kent State University for informing me of this locality's existence and to the Morton Salt Company for collecting privileges.

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LITERATURE CITED

FERNALD, M.L. 1950. Gray's Manual of Botany. American Book Company, New York.

WEISHAUPT, C. G. 1968. Vascular Plants of Ohio. Wm. C. Brown Book Company, Dubuque, Iowa.

A RANGE EXTENSION FOR ODONTITES SEROTINA (LAM.) DUM. (SCROPHULARIACEAE): This somewhat weedy species, an adventive from Europe, has heretofore been reported to extend from Newfoundland to western Quebec, south to Nova Scotia, northern New England, and northern New York (Fernald, Gray's Manual, 8th Edition, 1950; Gleason and Cronquist, Manual of Vascular Plants, 1963 — but these latter exclude Newfoundland from the range).

This is to report a remarkable extension of the plant's range into northeastern Wisconsin. Mr. Tom Brudnicki, a student, collected the plant in a wooded swamp in the SW part of section 19, T27N, R19E, Oconto County, Wisconsin, 14 September 1968 (*Brudnicki* 053). He returned to the site 6 September 1969 and collected numerous others (*Brudnicki s.n.*). Vouchers for both collections are deposited in the herbarium, Wisconsin State University-Oshkosh, and duplicates of the latter collection have been distributed to WIS, UWM, GH, and NY. Peter Salamun (1951. Preliminary Reports on the Flora of Wisconsin. XXXVI. Scrophulariaceae. Trans. Wis. Acad. Sci., Arts and Letters. 40(2): 111-138) does not report the plant for Wisconsin, nor are there any records for the plant in Wisconsin at UWM. Hugh Iltis (personal communication) informs me that WIS has one record of this species from Door County and one from adjacent Kewaunee County, both collected since 1951. These records are sufficiently extensive to warrant including this species as a member of the Wisconsin flora.

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A NEW ARGENTINE SISYRINCHIUM

ROBERT C. FOSTER

Among the unnamed specimens of South American *Sisyrinchium* in the Gray Herbarium, there is one from Argentina that appears to represent an undescribed species, and is here described.

Sisyrinchium papillosum R. C. Foster, spec. nov. Planta parva, plus minusve caespitosa, e rhizoma breve angustoque. Folia basalia, ad 10 cm. longa et 2-3 mm. lata, glauca, dense breveque papillata, inflorescentiam excedentia. Inflorescentia terminalis, non pseudo-lateralis, spathae plurifloraе. Spathae inaequales, exterior quam interior longior, ad 2.4 cm. longae, glaucae, plusminusve dense papillatae. Pedicelli glanduloso-villosi, pili lutei, quam spatham interiorem ad anthesin breviores vel plusminusve aequantes. Ovarium oblongum, ad 3-3.5 mm. longum, dense glanduloso-pubescens, pili lutei. Tepala subaequalia, lutea, venis atrobrunneis, ovata vel obovata, acuta, ad 1 cm. longa et 4-5 mm. lata, ad basim adaxialiter plusminusve glanduloso-villosa. Filamenta coalita 2.5 mm., dense glanduloso-villosa, libera plusminusve 1.8 mm.; antherae oblongae, circa 2 mm. longae. Styli rami plusminusve 2 mm. longi, quam antherae multo breviores. Capsula glanduloso-pubescens vel glabrata. Semina matura non visa.

ARGENTINA: MENDOZA: TUMUYAN: ad ripas rivulorum pr. Cuesta de los Aflijidos, iter Andinum Paso del Portillo dicto, 24 Dec. 1933, *A. Ruiz Leal* 1875 (type, in Gray Herb.).

The partially united filaments with long, oblong anthers ally this species with the *Sisyrinchium Marchio* complex and to others such as *S. avenaceum* Klatt or even *S. Wettsteinii* Hand.-Mazz. It differs from these in smaller size, glaucous leaves and spathes, these being densely short-papillate, and in the glandular villosity of the united portion of the filaments and basal portion of the adaxial tepal-surface.

GRAY HERBARIUM, HARVARD UNIVERSITY
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Schultes, Richard Evans — March 4, 1938
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Baldwin, John Thomas, Jr. — December 1, 1944
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Boivan, Bernard — May 2, 1947
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Brainerd, John Whiting — November 1, 1940
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Cody, William James — February 4, 1955
Plant Research Institute
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Cronquist, Arthur John — April 7, 1961
New York Botanical Garden
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Dahl, Anthony Orville — January 6, 1939
Morris Arboretum
9414 Meadowbrook Avenue
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Dansereau, Pierre — December 1, 1944
New York Botanical Garden
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Demaree, Delzie — December 1, 1944
109 South Avenue
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Downes, Robert Marshall — January 6, 1967
South Londonderry, Vt. 05155

Dressler, Robert Louis — February 6, 1953
Smithsonian Tropical Research Institute
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Drew, William Bradford — May 13, 1932
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Drouet, Francis — March 4, 1938
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Dudley, Theodore R. — December 6, 1963
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Dunbar, Henry Fowler — May 1, 1914
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Duncan, Wilbur Howard — March 3, 1950
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University of Georgia
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Earle, Sylvia — March 6, 1970
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Einarsson, Eythor — February 5, 1960
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Eldredge, Keith Graham — November 2, 1945
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Ernst, Wallace Roy — January 5, 1962
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Fogg, John Milton, Jr. — December 3, 1926
Barnes Arboretum
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Garton, Claude Eugene — February 4, 1955
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Gillett, John Montague — April 2, 1954
Botany & Plant Pathology Division
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Glime, Janice — December 5, 1969
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Goodman, George Jones — January 5, 1945
University of Oklahoma
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Goodwin, Richard Hale — December 5, 1930
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Gustafson, Alton Herman — June 1, 1934
Bowdoin College
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Habeeb, Herbert — January 5, 1945
Auburn Community College
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Hand, Byron Eugene — January 7, 1955
6 Caroline Avenue
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Botanical Institute
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Hermann, Frederick Joseph — December 1, 1944
Forest Service Herbarium
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Westledge School
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Hopkins, Milton — January 15, 1932
Port Washington Boulevard
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41 Graden Street
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Jablonski, Eugene — December 5, 1958
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Lownes, Albert Edgar — March 7, 1952
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Manning, Wayne Eyer — February 2, 1934
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Pride, George Howard — December 1, 1939
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Raup, Hugh Miller — December 6, 1929
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Rudolph, Emanuel David — March 2, 1956
Department of Botany & Plant Pathology
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Schaeffer, Robert L., Jr. — February 4, 1955
32 North 8th Street
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Seymour, Frank Conklin — December 4, 1914
Pringle Herbarium
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Sharp, Aaron John — December 1, 1944
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University of Tennessee
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Shinners, Lloyd Herbert — February 4, 1955
The Herbarium
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Smith, Ernest Chalmers — March 4, 1955
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Soper, James Herbert — December 1, 1939
Museum of Natural Sciences
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St. John, Harold — December 1, 1911
Bishop Museum
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Steele, Frederic Lincoln III — February 3, 1939
St. Mary's-in-the-mountains
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COMPARATIVE STUDIES OF SMILAX, SECTION SMILAX, OF THE SOUTHEASTERN UNITED STATES

IDA E. YATES AND WILBUR H. DUNCAN

The species of the genus *Smilax* L. of the section Smilax (LILIACEAE) are unusual monocotyledons. In addition to possessing reticulate veined leaves, the taxa of this section are woody, dioecious vines with "stipular" tendrils. The combination of the above vegetative characters defines the Smilax section of *Smilax* as a distinctive, easily recognizable group. However, identification of specimens, especially sterile ones, to taxa within the section is often difficult. Also concepts of phylogenetic relationships between taxa are not clearly established and certain leaf characteristics pointed out by Duncan (1967) are not identified as to their structural nature. Therefore, attempting to alter these situations, we investigated each woody species of *Smilax* indigenous to the southeastern United States (Duncan, 1967), except *S. pumila* Walt., for epidermal and gross anatomical similarities and differences of leaves.

The specimens examined in this study are of *S. auriculata* Walt., *S. bona-nox* L., *S. glauca* Walt., *S. laurifolia* L., *S. rotundifolia* L., *S. smallii* Morong, *S. tamnoides* L., and *S. walteri* Pursh. as interpreted by Duncan (1967). Three leaf forms of *S. bona-nox* (auriculate, ovate, and cordate), and two of *S. tamnoides* (orbicular and hastate, varieties *hispida* and *tamnoides*, respectively) were treated separately, making eleven kinds of *Smilax* studied.

Confusion as to the delimitation of the species of *Smilax* dates back at least to 1753 with Linnaeus' *Species Plantarum*. As Fernald (1944) adeptly points out, Linnaeus had no clear understanding of American species, and his citations cover different species. Other investigators have also disagreed regarding taxa. Morong (1894) describes *S. smallii* as a new species while maintaining *S. lanceolata* L. as a separate taxon and recognizes *S. hispida* Muhl. and *S. beyrichii* Kunth *in sensu S. tamnoides* L. and *S. auriculata* Walt., respectively. Small (1933) assigns *S. pseudochina* L. and *S. tamnoides* to the species *S. bona-nox* and *S. beyrichii*, and *S. smallii* to the species *S. lanceolata*. He accepts *S. hispida* as *S. tamnoides*.

Caponetti and Quimby (1956) studied anatomical structures of roots, leaves, aerial stems, and rhizomes of *S. tamnoides*, *S. auriculata*, *S. bona-nox*, and *S. glauca*. They report the last species as the only one possessing papillae on the lower leaf epidermis and having thick-walled circular lignified cells in the region of the mesophyll beneath the midvein. They isolate *S. bona-nox* on the basis of the cells surrounding the midvein having thick lignified walls toward the midvein and thin non-lignified walls away from the midvein.

Arber (1920) studied the anatomy of the tendrils of *Smilax* and interprets them as being equivalent in morphological value to the petiole and having originated through that structure. She maintains that the blade of *Smilax* is not equivalent to the lamina of a dicotyledon, although quite similar in appearance internally, but is merely a "pseudo-lamina" representing an expansion of the upper region of the petiole. The thickened tip which characterizes the blade of some members of the genus is possibly the last relic of the unexpanded petiolar apex. Thus each tendril on her interpretation is equivalent to the petiole and these to the pseudo-lamina.

Coker (1944) made an extensive study of woody *Smilax* of the United States. He gives comprehensive descriptions and discussions of each species, pointing out important

omissions and errors found in manuals and other writings. New data concerning underground parts are emphasized. Information is given on epidermal features of leaves of some taxa, but it is scanty, and mostly concerns stomates.

Sixty-one fresh and dried specimens were utilized in this study. Identification by collection data and University of Georgia Herbarium acquisition number is given by Yates (1968). Two mature leaves were taken for study from each fresh collection, one large and one small. The remainder of the collection was pressed, dried, mounted, and deposited as a voucher specimen. Additional material was obtained for study by removing one mature leaf from each of a number of selected herbarium specimens previously on deposit and reconstituting it by treatment with 0.1 Normal NaOH at 60°C for 24 hours.

An outline drawing was made of each leaf chosen for study and a segment one mm wide cut out one-tenth of the distance of the total length beneath the tip. Two more segments were taken directly below the first one. The leaf segments were placed in FAA (5 ml formalin: 5 ml glacial acetic acid: 90 ml 50% ethyl alcohol).

Epidermal imprints were made from each leaf using a modification of the technique described by Sinclair and Dunn (1961). They were taken along the horizontal axis of the leaf from midvein to margin at a point approximately one-third the total leaf length from the tip. Surface feature studies were first attempted from imprints made from dried material. Our stomatal counts were obtained from these preparations. Later, material preserved in FAA or reconstituted with NaOH was used to make imprints for analyzing the other surface features. Imprints were made from three leaves of each of five collections from each of the eleven kinds of *Smilax*.

The terminology used to describe epidermal cells and venation is self-explanatory; however, those most likely to be misinterpreted will be described below. The others are described by Yates (1968). Veinal cells refer to those epidermal cells in areas above or below veins. Midvein and

lateral veins are those arising at the base of the blade and extending longitudinally to the apex. Secondary veins are those extending horizontally from any one of the above veins to any other. Venule reticulum includes all the small veins in the leaf forming the anastomosing network characteristic of the genus *Smilax*.

For the sake of brevity, the imprints of features of the epidermal cells will be referred to henceforth by the name of the feature involved. Configuration of lateral cell walls is described as straight, curved, or undulate. Straight denotes those epidermal cells having at least three walls without undulations although the walls may be bowed, especially at junctions with adjacent cells. Undulate refers to those cells having at least two walls each with 2.5 or more undulations that are 25 or more microns high. Curved indicates those epidermal cells which fall between straight and undulate.

Microscopic counts and length and width measurements of the stomates were made in five fields of vision 0.093 mm^2 in area on imprints from three dried leaves of each collection. If any part of a stomate was in the field of vision, it was included in the count. The means of these three characteristics were tested for significant differences by Duncan's new multiple-range test (Steel and Torrie, 1960).

For gross anatomical observations, the first segment cut from the large leaf in the procedure described previously was dehydrated through a tertiary butyl alcohol series, embedded in paraffin, and sectioned at ten microns. The sections were mounted using a modification of Haupt's adhesive and stained with Conat's quadruple stain (Johansen, 1940). A second series of sections was stained using aniline blue and safranin as a countercheck on the former. The characteristics of the cuticle, epidermis, mesophyll, and vascular system were studied from these preparations. Two to five specimens of each of the eleven kinds of *Smilax* were studied anatomically.

Freehand cross sections of dried, preserved, and reconstituted material of selected species were stained with a

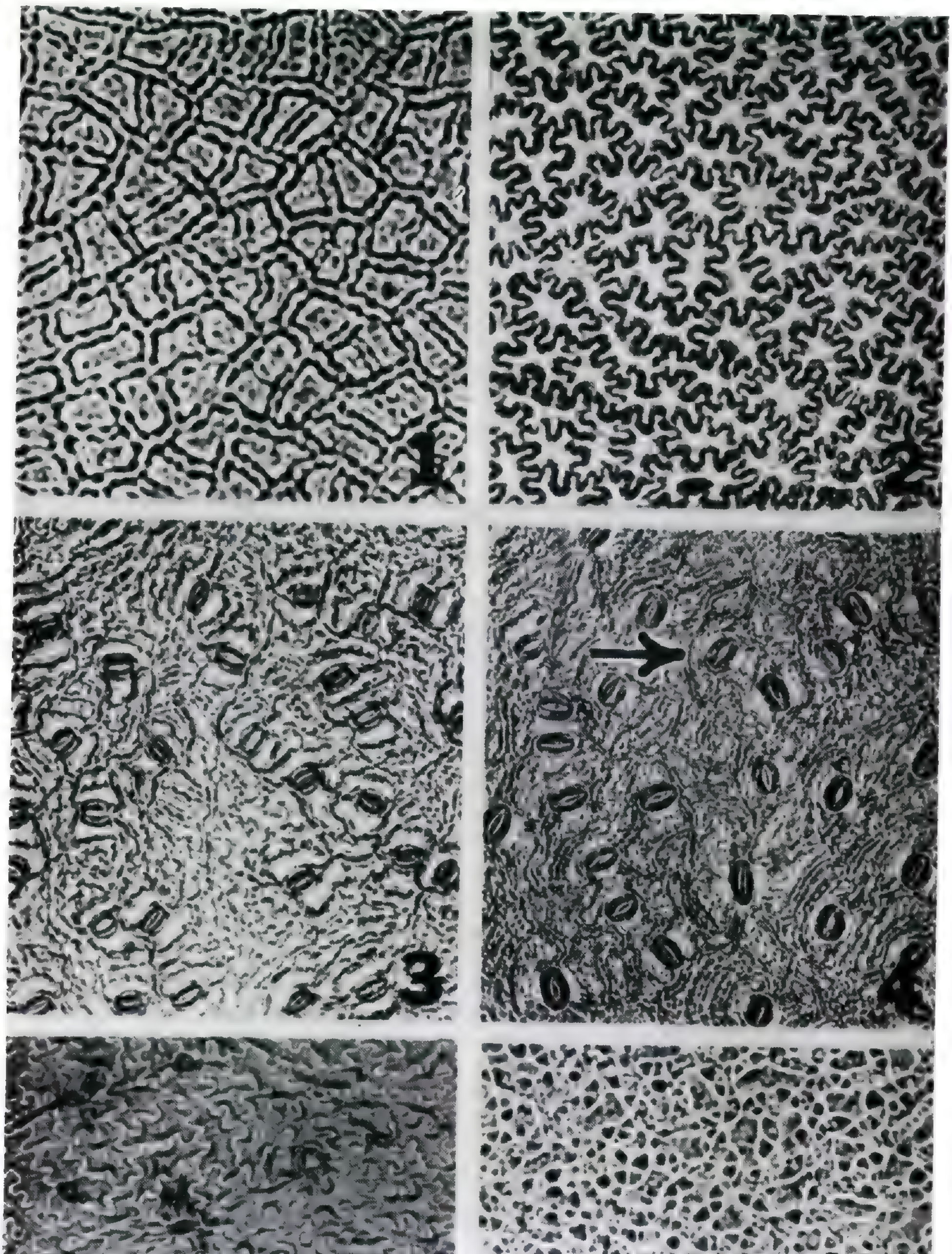
1% solution of phloroglucin in 95% ethyl alcohol and 25% hydrochloric acid (Johansen, 1940), as a specific test for localization of lignified cell walls.

Study of the epidermal imprints and cross sections revealed characteristics which varied from those common to all taxa of *Smilax* studied to those which were unique to single taxa. The interpretations presented below are necessarily based on characteristics of the leaf at the positions where data were obtained, namely one-tenth of the total leaf length beneath the tip for cross sections and one-third of the length for the epidermal imprints. We do not maintain or imply that the characteristics are the same elsewhere. The surface features and gross anatomy of the leaves will be presented separately.

Characteristics of the stomatal cells could be determined from epidermal imprints made from untreated dried material. However, imprints made from FAA preserved or NaOH reconstituted specimens were required for most characteristics of the other epidermal cells.

The appearance of cells at the marginal and veinal areas is that of parallelly aligned, rectangularly elongated structures with striated surfaces and thick cell walls. On the upper epidermis, the interveinal cell type generally changes abruptly to the marginal type; whereas, on the lower epidermis, the change is gradual. The number of rows of distinctly marginal cells of the upper epidermis ranges from 8 to 14.

Typically the number of rows of rectangularly elongated cells at the midvein is approximately three times greater on the lower epidermis than on the upper. Although there are exceptions within some taxa, the cells of the interveinal areas change abruptly at all veinal areas. At the midvein, the number of rows of rectangularly elongated upper epidermal cells is 2 to 11; at the lateral veins, 2 to 8; and at secondary veins, 0 to 5. Generally, there are no rectangularly elongated cells above the venule reticulum on the upper or lower epidermis. The number of rows of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rectangularly elongated lower epidermal cells at the midvein is 5 to 50; at the lateral veins, 0 to 11; and at the secondary veins, 0 to 3.

Although cells of interveinal regions vary considerably from species to species, there are some characteristics which are common to all. All cells of interveinal regions are irregularly aligned (Figs. 1, 2). Generally, undulated cell walls (Fig. 2) are thinner than straight cell walls (Fig. 1). At corresponding locations on the upper and lower epidermises, the cells are essentially the same size. Adjacent cells at any given interveinal location, with the exception of *S. smallii*, are essentially the same size.

The stomatal-subsidiary cell relationship of all species in the terminology of Metcalf and Chalk (1950) is paracytic (Fig. 3). The distal ends of the stomates in all species are aligned at various angles with respect to the longitudinal axis of the leaf (Figs. 3, 4). Differences in microscopic counts and measurements of the stomates, without quantitative measurements and statistical treatment, are usually not sufficiently evident to a cursory examination with the microscope to allow quick identification of taxa. The mean stomatal frequency in a field of vision of 0.093 mm^2 is 3.6 to 5.6; the mean stomatal length, 35.3 to 52.9 microns; and the mean stomatal width, 17.9 to 28.6 microns.

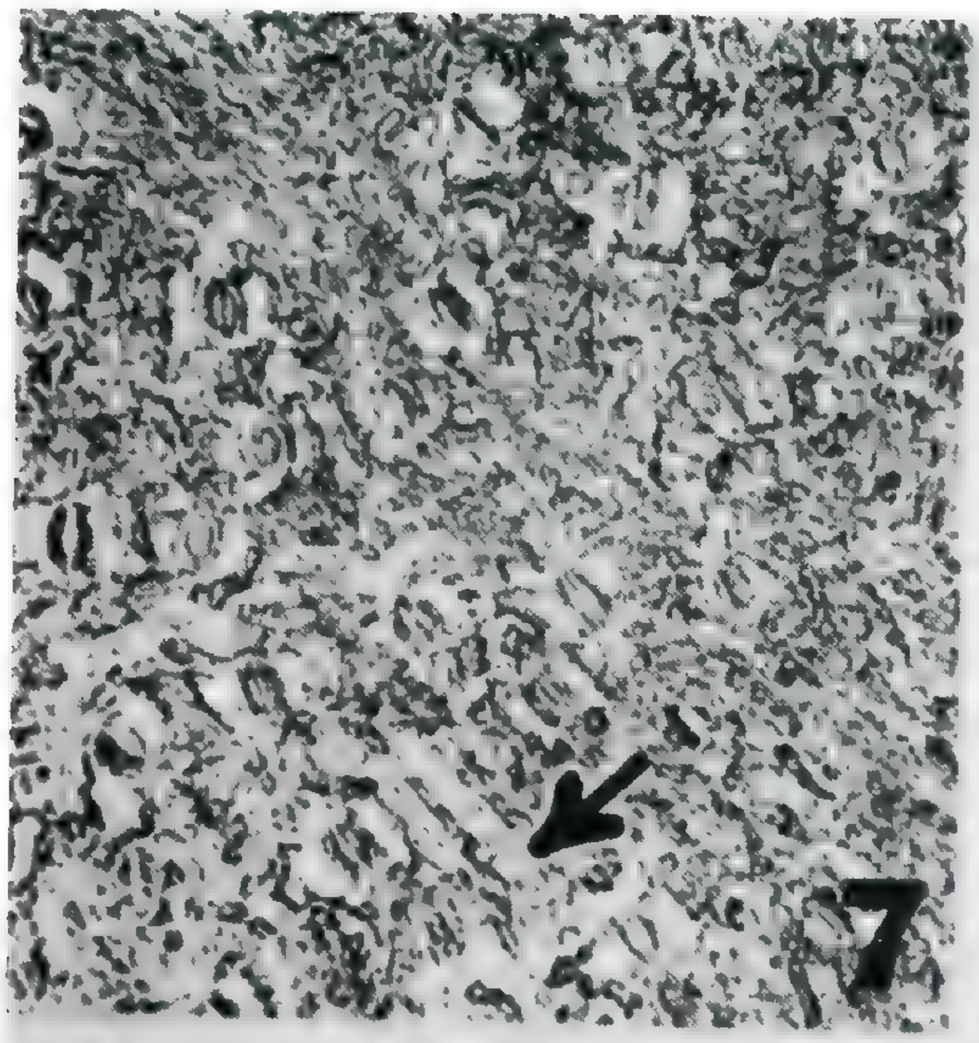
Many differences in epidermal characteristics of the various kinds of *Smilax* studied were revealed by critical examination of the imprints. Those individually unique to a given taxon will be presented first.

The unique characters are as follows:

S. auriculata: One of the two subsidiary cells is crescent

FIGURES 1-6. Epidermal imprints, × 125.

Fig. 1. *S. auriculata*, upper. Note indistinct features due to rough surface cell walls. Fig. 2. *S. glauca*, upper. Fig. 3. *S. bona-nox*, lower, showing large paracytic type subsidiary cells. Fig. 4. *S. auriculata*, lower. Note irregular outer surface of cell walls. Arrow at crescent shaped subsidiary cell. Fig. 5. *S. rotundifolia*, lower, showing striated subsidiary cells. Fig. 6. *S. smallii*, upper, showing large cells separated from each other by a row of much smaller cells.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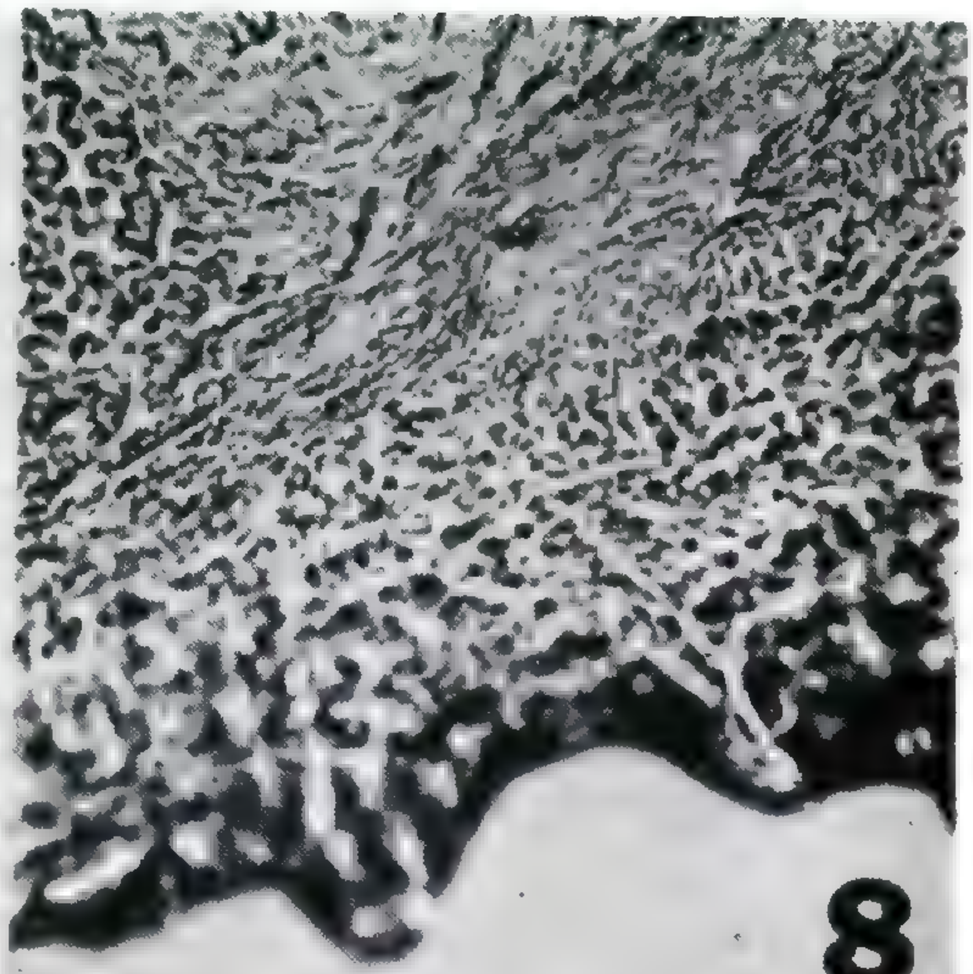
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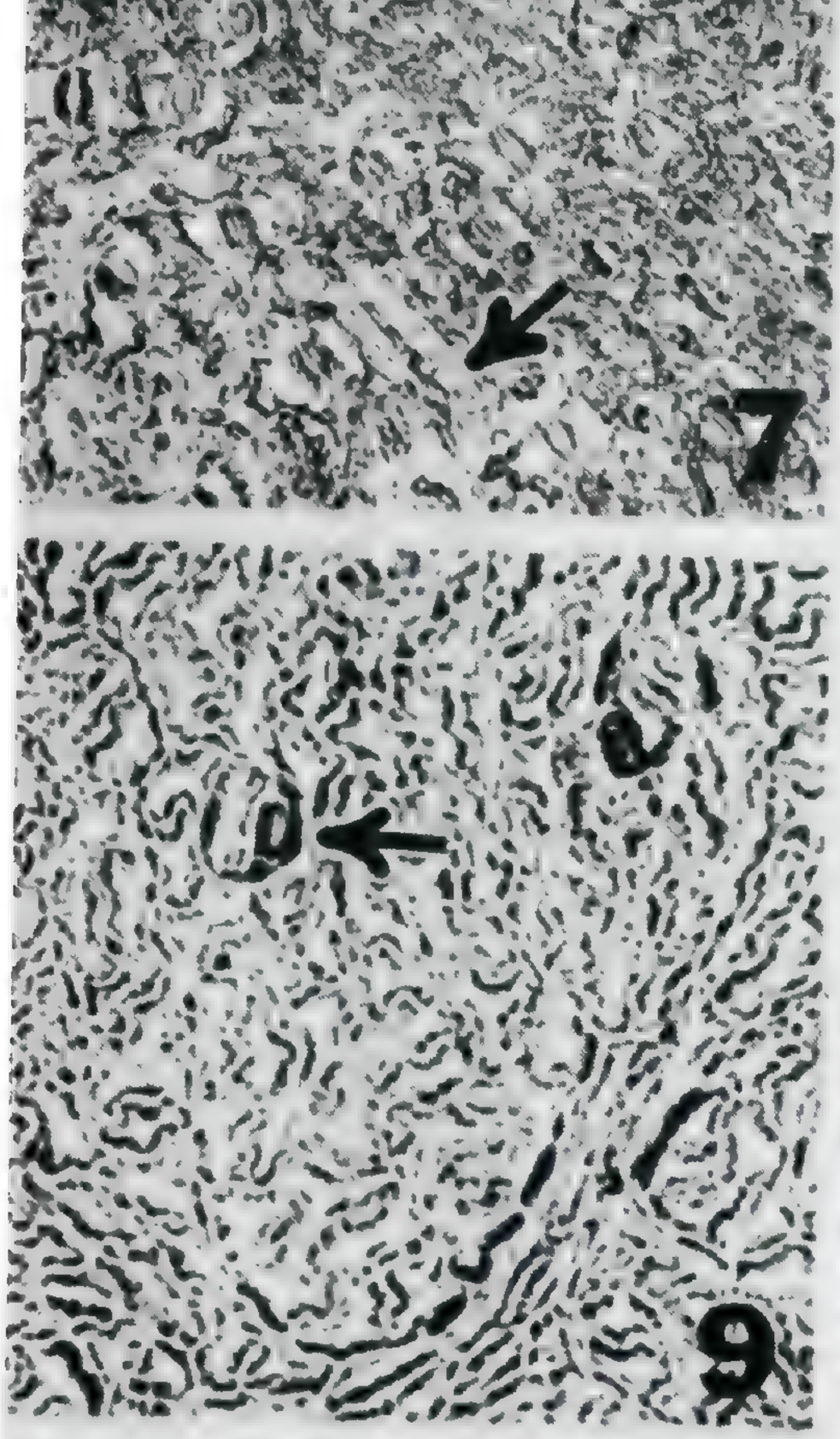
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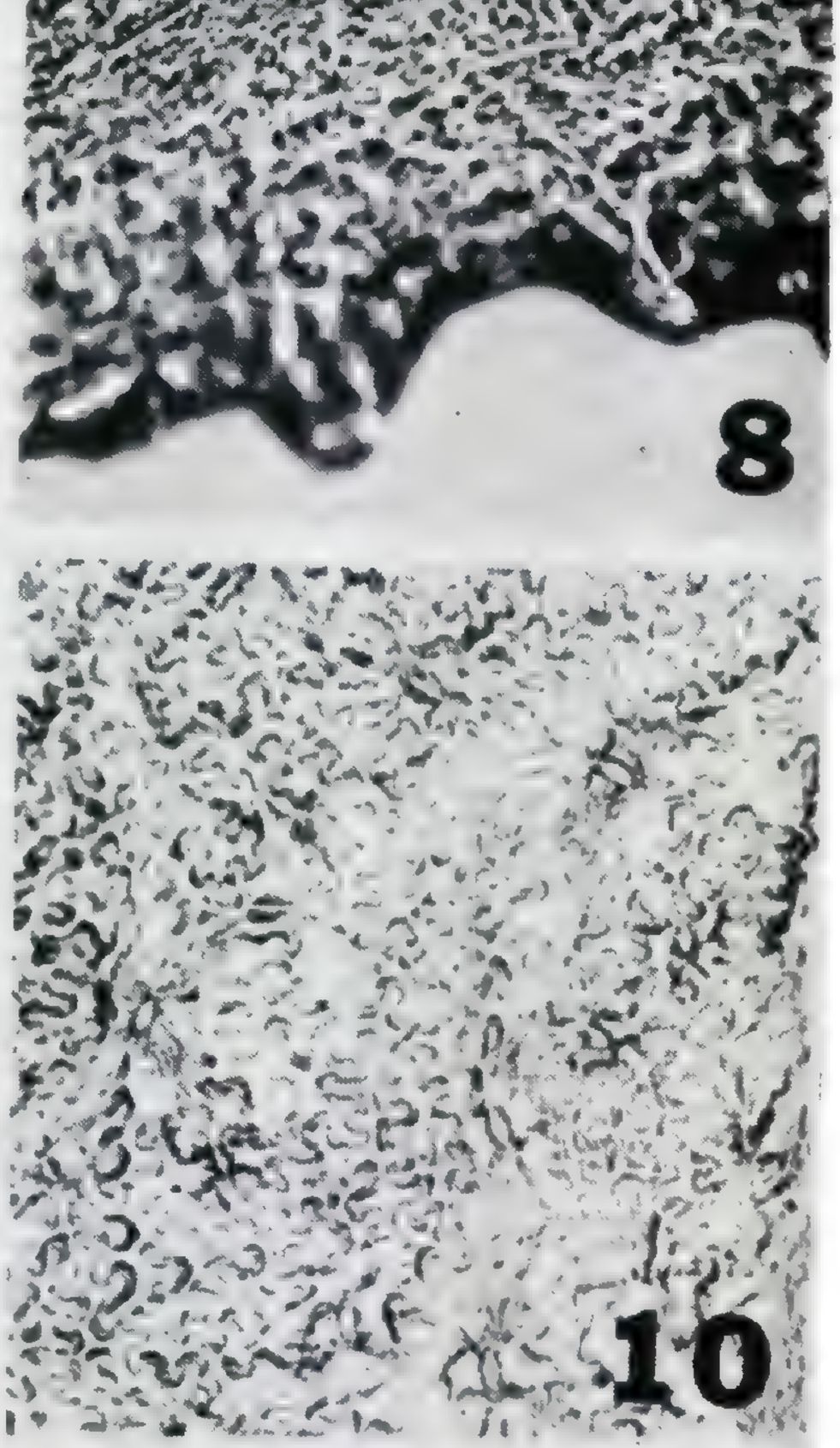
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shaped (Fig. 4), rarely otherwise. In other taxa these are similar in shape to other interveinal cells (Fig. 5).

S. smallii: Interveinal areas of the upper epidermis have large cells separated from each other by a row of much smaller cells, about one-sixth the size of the former (Fig. 6). Also, this is the only taxon having a combination of lateral cell walls of the upper epidermis with straight configuration and of the lower with undulate (Fig. 7).

S. tamnoides: Rectangular cells are present and striated at the venule reticulum on the upper and lower epidermis.

S. tamnoides var. *hispida:* Some marginal rectangular cells converge into minute marginal denticulations (Fig. 8).

S. walteri: Rectangular cells are present at the venule reticulum only on the lower epidermis. Also, this taxon is the only one with both upper (Fig. 9) and lower epidermal cells having a curved configuration, and with the exposed surface of the upper epidermal cells appearing depressed in the middle (Fig. 9).

Characteristics which are common to only two or a few kinds of *Smilax* are several:

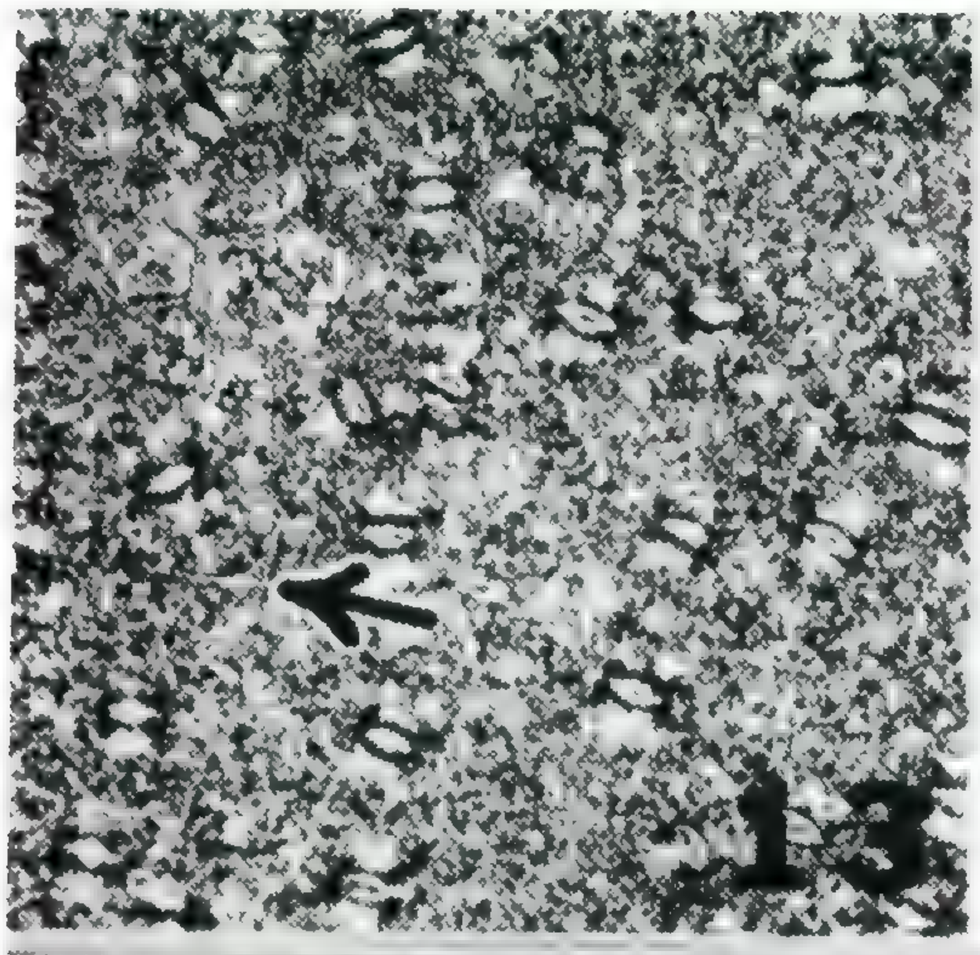
Stomates regularly present on the upper epidermis — *S. rotundifolia*, *S. walteri* (Fig. 9), frequently in *S. tamnoides*. These findings are essentially the same as those reported by Coker (1944) except that no stomates were found in *S. tamnoides*.

Surface of lower epidermal cells quite irregular — *S. auriculata* (Fig. 4), *S. laurifolia*.

Subsidiary cells larger than interveinal cells — *S. bona-nox* (Fig. 3), *S. smallii* (Fig. 7), *S. walteri*.

Surface of most subsidiary cells striated — *S. rotundifolia* (Fig. 5), *S. tamnoides* (Figs. 10, 11), *S. walteri*. A few striations were observed in *S. smallii* and in the ovate leaf form of *S. bona-nox*.

Fig. 7. *S. smallii*, lower. Arrow at undulate cell wall. Fig. 8. *S. tamnoides* var. *hispida*, upper. Fig. 9. *S. walteri*, upper. Arrow at stomate. Fig. 10. *S. tamnoides* var. *hispida*, lower. Fig. 11. *S. tamnoides* var. *tamnoides*, lower. Fig. 12. *S. glauca*, lower. Arrow at stomate.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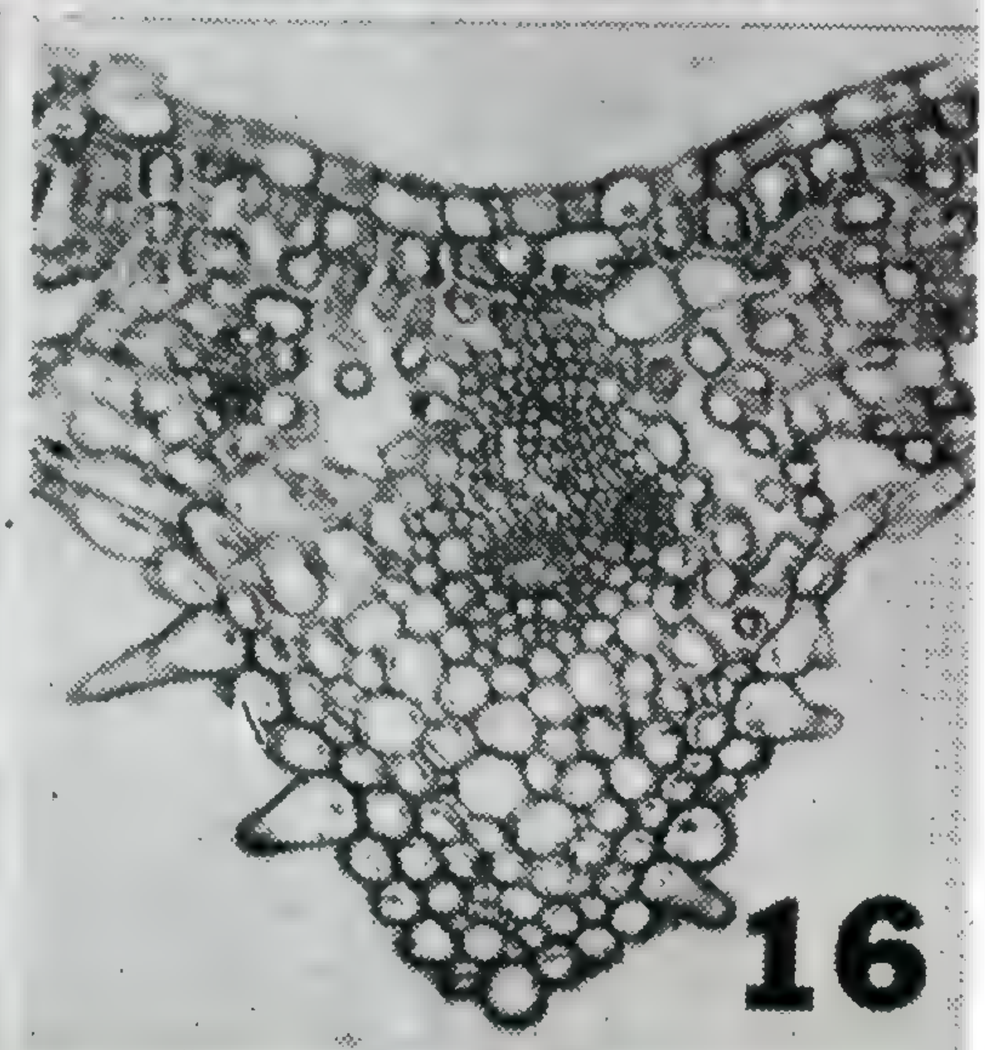
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Rows of marginal rectangular cells on the upper epidermis 10 or less — *S. glauca, S. rotundifolia*; more than 20 — *S. tamnoides, S. walteri*; 11-18 — the other four taxa.

Lateral cell walls usually both thick and having a configuration that is straight in the upper epidermis — *S. auriculata* (Fig. 1); *S. smallii* (Fig. 6); usually in *S. bona-nox*; and sometimes in *S. laurifolia, S. tamnoides* var. *tamnoides*. The configuration is curved in *S. walteri* (Fig. 9) and in three collections of *S. laurifolia* from mesophytic habitats. In all other instances (*S. glauca, S. rotundifolia*, six collections of *S. bona-nox*, and two of *S. tamnoides* var. *tamnoides*) the lateral cell walls are thin and have an undulate configuration (Fig. 2). The specimens of *S. bona-nox* having straight walls in the upper epidermis are all from maritime sandy habitats, whereas those with undulate walls are from the Upper Coastal Plain, Piedmont, and Blue Ridge. Configurations of the lateral cell walls of the lower epidermis are the same as for the upper except in *S. glauca* (Fig. 12) which has curved; *S. smallii* (Fig. 7), undulate; *S. laurifolia* (Fig. 13), always straight; *S. tamnoides* (Figs. 10, 11), always undulate; and *S. bona-nox* in which 6 of the 15 collections are undulate as compared to straight.

Exposed cell surfaces of the upper epidermis rough — *S. laurifolia* (Fig. 14); *S. auriculata* (Fig. 1); sometimes rough in *S. bona-nox, S. tamnoides*. They are smooth in other instances for the last two species and in the other taxa (Fig. 6).

Exposed surfaces of the lower epidermal cells smooth (Fig. 11) — all taxa except *S. auriculata* and *S. laurifolia*.

Fig. 13. *S. laurifolia*, lower. Note indistinct features due to ridges on surface walls. Arrow at straight cell wall. Fig. 14. *S. laurifolia*, upper. Note indistinct features due to rough surface walls.

Fig. 15. *S. tamnoides* var. *hispida*, showing duct and marginal denticulation. Fig. 16. *S. glauca*, showing papillose lower epidermal cells and prominent midrib. Fig. 17. *S. laurifolia*, showing large first row of palisade and lack of protruding midrib. Fig. 18. *S. bona-nox*, showing sclerenchyma cells in leaf margin.

In the latter species the surface is so deeply ridged as to render imprints opaque when viewed with the naked eye. The ridges obscure cell wall outlines on imprints from *S. laurifolia* (Fig. 13) to the extent that under microscopic examination maximum illumination is usually necessary to discern the configuration of the lateral cell walls.

The ratio of the number of rows of rectangular cells at the midvein of the lower epidermis to the number at the margin is lowest in *S. laurifolia* and *S. smallii* (0.3-0.7) and highest in *S. bona-nox* (0.6-2.0). The ratios for these and the other taxa are given by Yates (1968).

The means for stomatal frequency per 0.093 mm^2, and stomatal length and width measurements in microns are presented in Table 1. Means connected by one or more of the lines beneath are not significantly different at the levels indicated. Means not connected are statistically significant. Each species is indicated by the first letter of the specific epithet, and where applicable, the second letter designating the leaf form or varietal epithet. The leaf forms of *S. bona-nox* are indicated by Ba, Bo, and Bc. The varieties of *S. tamnoides* are designated by Th and Tt.

Sections stained with safranin-aniline blue proved to be more satisfactory for studies of the cuticle, and those stained with Conat's quadruple combination enabled a more discrete examination of the vascular system. Both staining procedures were equally revealing of other aspects of the gross anatomy.

The surface of the cuticle in all species is smooth on the adaxial side and irregularly ridged on the abaxial side. In most species, it is thicker on the adaxial surface than on the abaxial surface and thicker still at the margins. At the leaf margins of most species, rib-like cuticular projections extend inwardly between the radial walls of the epidermal cells.

The continuity of the uniserate, compactly arranged epidermis is interrupted only by the presence of stomates and the aforementioned cuticular projections. Stomates are more distinct and more frequent in the lower epidermis of

Table 1 Mean values of stomatal frequency per 0.093 mm² (I) and stomatal length (II) and width (III) in microns, and the significance of the difference between means[1] for eleven kinds of *Smilax*.[2]

I

Tt	R	Th	Bo	A	Bc	L	S	W	Ba	G
3.61	4.33	4.45	4.46	4.47	4.54	4.71	4.91	4.91	5.23	5.61

II

G	R	Th	Tt	W	S	Bo	Bc	Ba	A	L
35.3	39.0	40.8	43.0	45.4	47.9	49.9	50.3	52.1	52.9	55.3

III

G	W	Tt	R	Th	L	S	Ba	Bc	Bo	A
17.9	19.9	21.7	21.8	22.5	25.3	26.5	27.9	28.5	28.6	28.6

[1]Not significant at 1% level ———, at the 5% level – – – –. Explanation in text.

[2]Abbreviations indicate kinds of *Smilax* and are explained in the text.

all species than in the upper epidermis, where in most species they are completely absent. As seen in cross section, the epidermal cells adjacent to the guard cells do not differ markedly from other epidermal cells. In all taxa, the stomates are slightly sunken below, or are level with, the surface of the other epidermal cells. Outer and inner stomatal ledges as described by Esau (1953) project into the stomatal cavity.

At corresponding locations on the adaxial and abaxial sides of the leaf, the epidermises are of approximately equal thicknesses. The cells of the epidermis of most species are rectangular and thick-walled, gradually changing into circular cells with still thicker walls at the leaf margins and veinal areas. At the midrib, more cells are circular and thicker walled in the lower epidermis than in the upper epidermis; whereas, at the major lateral veins, as many cells possess these characteristics in the upper epidermis as in the lower epidermis. The epidermal cells contain no well developed plastids.

The mesophyll is differentiated into palisade parenchyma on the abaxial side. The palisade parenchyma is compactly arranged and may be composed of from one to three layers of cells. The spongy parenchyma is loosely arranged and may be composed of from three to ten layers of cells. At the margins and veinal areas, the mesophyll cells are typically thicker walled and more compactly arranged than mesophyll cells of interveinal regions. They may differ in size, shape, lignification of walls, and affinity for safranin.

The veinal system is composed of collateral vascular bundles with the largest vein being directed along the median longitudinal axis of the leaf. Sclerenchyma encloses the midvein and the major lateral veins. Surrounding the sclerenchyma is a bundle sheath composed of thin-walled parenchymatous cells with a chloroplast complement similar to the mesophyll. As previously stated, the tissue above and below major veins may differ from the mesophyll of interveinal areas.

Randomly scattered throughout the mesophyll of the leaf

cross sections are ducts (Fig. 15) which appear to be single celled and seem either to be void of contents or to contain compact clusters of elongated crystals. The ducts may have thick or thin walls. They may run longitudinally or at an angle.

Many differences in the gross anatomy of leaves of the kinds of *Smilax* studied were revealed by critical examination of the cross sections. Those individually unique to a given taxon will be presented first.

The unique characters are as follows:

S. glauca: Many lower epidermal cells are papillose and most outer walls convex (Fig. 16). The papillae are the most conspicuous in leaves of plants from the more moist habitats and least evident in those from drier habitats. These cells are flattened or rounded and lack papillae in the other species. Coker (1944) reports papillae for his "roughened" form of *S. glauca* but not for his "glabrous" form. In making no reference to papillae in the other taxa he studied, the impression is left that none were found. In our studies also, the ratio of the thicknesses of the cuticle at the margin of the blade to the thickness of the adaxial cuticle at an interveinal area 1.5 mm from the margin is always less than 2:1. In all other taxa it is greater than 2:1. In addition, the ratio of the thickness of the cuticle of the upper epidermis to that of the lower is 4:1 or greater, whereas in other taxa the ratio is about 2:1 or less.

S. tamnoides: Uppermost palisade parenchyma cells are not as thick or are as thick as the upper epidermal cells (Fig. 15), whereas they are thicker than the upper epidermal cells in all other taxa. Also mesophyll cells at the leaf margin differ from those of interveinal mesophyll by being irregularly shaped and small.

S. tamnoides var. *hispida:* Marginal denticulations are discernible from serial cross sections (Fig. 15).

S. laurifolia: The leaf thickness (about 670 microns) at interveinal areas near the midvein is greater (Fig. 17) than for the other species in which the thickness is usually between 330-370 microns (e.g., Figs. 15, 16, 18). Upper-

most palisade parenchyma cells are more than 2× as thick as upper epidermal cells (Fig. 17). These palisade cells may be nearly this large in *S. rotundifolia*. In all other taxa they are smaller. Also, *S. laurifolia* is the only taxon in which the cuticle on the lower epidermis is thicker than on the upper.

S. bona-nox: More than 15 sclerid cells are in the leaf margin (Fig. 18). Other taxa have none or only one or two such cells.

S. auriculata: Upper epidermal cells are seven or more microns thicker than the lower. In other taxa they are about the same thickness.

Gross anatomical characteristics which are common to only two or a few kinds of *Smilax* are:

Rib-like cuticular projections between marginal epidermal cells — *S. bona-nox*, *S. laurifolia*, *S. smallii*, and *S. walteri*; often in *S. auriculata* and *S. tamnoides*.

Some cell walls adjacent to sclerid cells around veins lignified, the opposite walls not — *S. bona-nox*, *S. tamnoides*.

More sclerenchyma cells on the adaxial side of the major veins than on the abaxial — *S. auriculata*, *S. laurifolia*. Circular cells in the mesophyll at the leaf margin differing from cells of the interveinal mesophyll — *S. laurifolia* and *S. smallii* have smaller circular cells; *S. glauca* has circular cells but they are as large as adjacent interveinal cells.

Conspicuously enlarged cells below the midvein — *S. glauca*; occasionally in *S. rotundifolia* and *S. smallii*.

Midrib generally not protruding — *S. laurifolia* (Fig. 17); barely protruding in *S. smallii*. *Smilax glauca* possesses a most prominent, often ridged, midrib (Fig. 16). The midribs of the other taxa are prominent but are more rounded than in *S. glauca*.

Although as indicated above there are differences between cross sections of *S. rotundifolia*, *S. smallii*, and *S. tamnoides*, the general aspect of sections of the species are quite similar.

Differences between some species occur in the safranin stained protoplast of the mesophyll and epidermis. The

protoplast of the mesophyll of *S. laurifolia* and *S. walteri* is so abundantly stained that the sections are obviously darkened. This protoplast is stained in some of the other species, but there is no gross effect as in the above two species. Except for the two species, staining characteristics are not gross in nature and are not described here. They are described by Yates (1968).

A few other minor differences in gross anatomical characters between taxa are given by Yates (1968).

The results of the present study differ in several respects with the earlier leaf anatomical investigations of Caponetti and Quimby (1956). They report no papillae on the midrib of the lower epidermis. We observed some on the collections from mesophytic habitats. Their failure to find papillae may be due to their collections having been from xerophytic environments only. Also, neither of the staining techniques used in this study reveals the presence of lignin which they reportedly detected in the mesophyll cells abaxial to the midvein of *S. glauca*. No explanation for these different observations seems possible from the information available. Their assumption that the extension of the sclerenchyma surrounding the midvein to the epidermis is characteristic of *S. auriculata* is the exception rather than the rule for specimens analyzed in the present study. Finally, *S. bona-nox* is not the only species, as they state, with the cells surrounding the sclerenchyma of the midvein having thick lignified inner walls and thin non-lignified outer walls. These peculiar cells are also frequently present in *S. tamnoides*. Because of the variation in the taxa involved, it is quite possible that the observations of Caponetti and Quimby were limited to too few specimens to detect the variability.

The present study has also revealed the structural nature of the marginal ribs indicated by Duncan (1967) for *S. bona-nox*, *S. auriculata*, and *S. laurifolia*. Externally these ribs often seem identical to veins but were not labeled as such because no veinal connections with nearby veins were observed. In *S. bona-nox* the rib is largely due to 15 or

more rows of sclerenchyma cells. In *S. auriculata* the rib seems due to the thick cuticle and compactly arranged subepidermal cells which also often has one or two sclerenchyma cells. In *S. laurifolia* a thick cuticle at the margin and compact subepidermal cells probably provide the rigidity to form a rib when the leaf is dried. Frequently some of the sclerenchyma cells in the leaf margin of *S. bona-nox* are much larger than the others and look like vessels. However, since our external and internal studies revealed no connection between the ribs and adjacent veins nor any phloem elements or bundle sheaths, we believe that the term "rib" should be continued in use for all three species.

Analysis of the data of the present study shows that in respect to surface features of the epidermises, the nine taxa differ by unique and/or certain combinations of characters. The same is true for gross anatomical characters. These data, therefore, support the species concept in the section Smilax as interpreted by Duncan (1967). In addition, the two varieties of *S. tamnoides*, as represented by the materials studied, differ in both surface features and gross anatomical characters. However, neither epidermal nor gross anatomical data were found separating the three leaf forms of *S. bona-nox*. Studies should be made in this species to determine whether or not specimens from maritime habitats consistently and exclusively have straight lateral cell wall configuration in the leaf upper epidermis. Such plants may be Coker's (1944) *S. bona-nox* var. *littoralis*. Similar studies should be made in respect to the undulate walls in specimens from other areas. Also, more study is needed to learn why the exposed epidermal cell walls in leaves of *S. walteri* appear depressed in epidermal imprints, yet as seen under microscopic examination of cross sections are not depressed.

Keys presented below emphasize many of the characters most distinctive for the nine taxa and allow identification of specimens on the basis of epidermal or gross anatomical characters. Although the two varieties of *S. tamnoides* may be separated, in the case of the materials we studied,

we hasten to point out that only specimens distinctly one type or the other were examined. Further epidermal and gross anatomical studies are necessary to determine whether the minute denticulations on the leaf margin of var. *hispida* exhibit intergradation as do the leaf forms as described by Duncan (1967). Under a dissecting microscope both varieties appear to have denticulations, but apparently in var. *tamnoides* this is due to uneven crimping and rolling of the especially thin margins of the blade.

Key to Taxa Based on Surface Features of Leaves

1. Upper epidermal cells of interveinal areas having larger cells each being separated from any other by a row of much smaller cells ..... *S. smallii*
1. Upper epidermal cells do not have such an arrangement of larger and smaller cells 2
   2. A crescent shaped subsidiary cell associated with the stomates on the lower epidermis ..... *S. auriculata*
   2. No crescent shaped subsidiary cell associated with the stomates on the lower epidermis 3
      3. Lateral cell wall configuration of lower epidermis curved 4
         4. Lateral cell wall configuration of upper epidermis undulated, stomates absent on upper epidermis ..... *S. glauca*
         4. Lateral cell wall configuration of upper epidermis curved, stomates present on upper epimis ..... *S. walteri*
      3. Lateral cell wall configuration of lower epidermis not curved 5
         5. Lateral cell wall configuration on lower epidermis straight 6
            6. Surface of lower epidermal cells of interveinal areas ridged ..... *S. laurifolia*
            6. Surface of lower epidermal cells of interveinal areas not ridged ..... *S. bona-nox*
         5. Lateral cell wall configuration on lower epidermis undulated 7

7. Lower epidermal cells associated with venule reticulum and striated *(S. tamnoides)* 8
8. Marginal cells converge to form minute marginal dentations ..... *S. tamnoides* var. *hispida*
8. Marginal cells do not converge to form minute marginal dentations ..... *S. tamnoides* var. *tamnoides*

7. Lower epidermal cells associated with venule reticulum not different from those of interveinal areas 9
9. Stomates present on upper epidermis, subsidiary cells about same size as interveinal cells ..... *S. rotundifolia*
9. Stomates absent on upper epidermis, subsidiary cells larger than interveinal cells ..... *S. bona-nox*

Key to Taxa Based on
Gross Anatomical Characters of Leaves

1. Fifteen or more sclerenchyma cells present in margin of leaf ..... *S. bona-nox*
1. Less than four sclerenchyma cells present in margin of leaf 2
2. Large papillose cells present in lower epidermis, ratio of thickness of the cuticle at the leaf margin to the thickness of the cuticle on the upper epidermis at an interveinal area 1.5 mm from the margin always less than 2:1 ..... *S. glauca*
2. Large papillose cells not present in lower epidermis, ratio of the thickness of the cuticle at the leaf margin to the thickness of the cuticle on the upper epidermis at an interveinal area 1.5 mm from the margin always 2:1 or greater 3
3. Uppermost palisade parenchyma cells not as thick as upper epidermal cells *(S. tamnoides)* 4

4. Marginal denticulations on leaf evident in serial cross sections ..... *S. tamnoides* var. *hispida*
4. Marginal denticulations on leaf not seen in serial cross sections ..... *S. tamnoides* var. *tamnoides*

3. Uppermost palisade parenchyma cells thicker than upper epidermal cells 5
5. Uppermost palisade parenchyma cells more than twice as thick as upper epidermal cells, cuticle on the lower epidermis thicker than on the upper ..... *S. laurifolia*
5. Uppermost palisade parenchyma cells not more than twice as thick as upper epidermal cells, cuticle on the lower epidermis as thick as or thinner than on the upper 6
6. More sclerenchyma cells on adaxial side of major veins than on the abaxial side ..... *S. auriculata*
6. As many or fewer sclerenchyma cells on the adaxial side of major veins as on the abaxial side 7
7. Small circular cells present in the mesophyll at the leaf margin ..... *S. smallii*
7. Small circular cells absent in the mesophyll at the leaf margin 8
8. Mesophyll deeply stained with safranin ..... *S. walteri*
8. Mesophylll scarcely stained with safranin ..... *S. rotundifolia*

We pointed out earlier that identification of sterile specimens to taxa is often difficult. Epidermal and gross anatomical characteristics revealed by this study help alleviate this problem. Gross anatomical characteristics are especially useful in the case of collections of *S. bona-nox* which, partly because of polymorphic leaf shapes, are often incorrectly identified as *S. rotundifolia*, *S. tamnoides*, *S. auriculata*, or

S. smallii. Even though the character of the marginal rib of *S. bona-nox* leaves can give positive identification, the diagnostic value of the rib is lessened because the thin margins which occur in some of the other taxa may be enrolled and appear enlarged, especially on dried specimens. Since our studies have revealed the margin to contain many sclerenchyma cells, positive identification of both dried and fresh specimens of *S. bona-nox* may be accomplished from freehand leaf cross sections of approximately 5 mm thickness by staining with phloroglucin as described earlier. Within five minutes this stain will impart a purple-reddish color to lignified structures, and examination with a 10× lens will reveal the presence or absence of the unique abundance of marginal sclerenchyma cells for *S. bona-nox.*

As is evidenced from the keys and other data presented earlier, all taxa possess both epidermal and gross anatomical characteristics that are distinguishing. However, except for *S. bona-nox* which is discussed above, epidermal imprints are more practical for identification purposes than are cross sections because of the time element and equipment involved. Imprint characteristics useful in checking identifications of specimens in some of the situations in which taxa are easily confused are pointed out below.

Some specimens of *S. smallii* are similar to those of *S. auriculata* and *S. laurifolia* but may be readily distinguished from them by a unique upper epidermis where each larger cell is separated from any other by a row of smaller cells approximately one-sixth the size of the former.

Smilax auriculata is easily distinguished from similar forms of *S. tamnoides* and *S. laurifolia* by a crescent shaped subsidiary cell flanking each stomate.

When specimens of *S. glauca* are dried, the glaucous nature of the underside of the leaf is often not apparent and the specimens are easily confused with those of *S. rotundifolia.* They may be identified by the absence of stomates in the upper epidermis of the former and by their presence in the latter.

Some leaf forms of *S. tamnoides* and of *S. rotundifolia* are similar. They may be identified by rectangular cells

above the venule reticulum of both upper and lower epidermises in the former, and by a higher ratio (2.5-5.0/0.8-1.0) of rows of rectangular cells beneath the midvein to rows at the leaf margin in the latter. *Smilax walteri*, which is often similar to *S. rotundifolia*, is distinguished from the latter by the same ratios of rectangular cells. In addition, *S. walteri* has curved lateral cell walls on both epidermises while in *S. rotundifolia* they are undulate.

Phylogenetic relationships between the Southeastern United States species of Smilax, excepting *S. pumila* which was not studied, seem more evident after an analysis of the data obtained in this study. A detailed presentment of presumed relationships does not seem justified here, but a summary of the more important aspects does. In coming to our conclusions, data published previously were considered as well as the data we obtained.

Smilax laurifolia is closely related to *S. auriculata* and *S. smallii* only, and these latter two species are much more closely related to *S. laurifolia* than to any other species. This is compatible with Coker's (1944) data on underground parts. Because of these strong relationships the three species should be considered as a single group even though *S. laurifolia* and *S. smallii* are not strongly related.

A second group of species consists of the closely related *S. bona-nox*, *S. tamnoides*, and *S. rotundifolia*. This group is loosely tied to the first by two similarities that *S. bona-nox* has with *S. auriculata* only and by one character it has with *S. smallii* only. Also, *S. tamnoides* has one character in common with *S. auriculata* only.

The remaining two species involved in this study, *S. walteri* and *S. glauca*, are not sufficiently related to be considered as a third group. They stand instead as single taxa with relatively weak relationships to each other and to certain taxa in the second group.

Smilax walteri is more closely related to *S. rotundifolia* than any other species. This is also supported by Coker's (1944) data on underground parts. *Smilax walteri* also has a character in common with *S. tamnoides* only. However, *S. walteri* has fewer ties to and more differences from the

members of the *S. bona-nox* — *S. tamnoides* — *S. rotundifolia* complex, than they to each other, and best should not be included with them.

The several unique characteristics of *S. glauca* place it considerably apart from the other species. It is more closely allied to *S. rotundifolia* and *S. walteri* than any other species and therefore should be placed nearest them in any phylogenetic scheme.

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A PRELIMINARY CHECKLIST OF THE MARINE ALGAE OF CAMPOBELLO ISLAND, NEW BRUNSWICK, CANADA[1]

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Although several investigators have reported on the benthonic marine algae of the Bay of Fundy-Passamaquoddy Region of New Brunswick, Canada, none except Edelstein, Chen and McLachlan (1970) have made detailed seasonal investigations and few have interpreted the observed distributional patterns. The present paper summarizes three years of observations and collections on the benthonic marine algae of Campobello Island, New Brunswick, which is in the southern portion of the Bay of Fundy.

The earliest record of marine algae from Campobello Island is given by Eaton (1873). He lists 11 species from Campobello in his account of the algae "in the vicinity of Eastport, Maine". Many other species mentioned are implied as being present. Farlow (1881) recorded only one species *(Rhodophyllis dichotoma)* from the Island. The collections of Hay (1887), Hay and MacKay (1886, 1888) and Fowler (1901, 1902) are from the environs of the Island, but they make no specific mention of Campobello Island. Klugh (1917) listed 24 species from selected sites on Campobello; again, many other species are implied as being present. Klugh was one of the first to record a variety of environments in the region and to discuss floristic differences in the Passamaquoddy-Bay of Fundy area. Bell and MacFarlane (1933), MacFarlane and Milligan (1965), Colinveaux (1966) and Edelstein, Chen and McLachlan (1970) have discussed the distribution of marine algae in the Bay of Fundy and adjacent waters. The latter workers summarized a year round study of the vegetation at Digby

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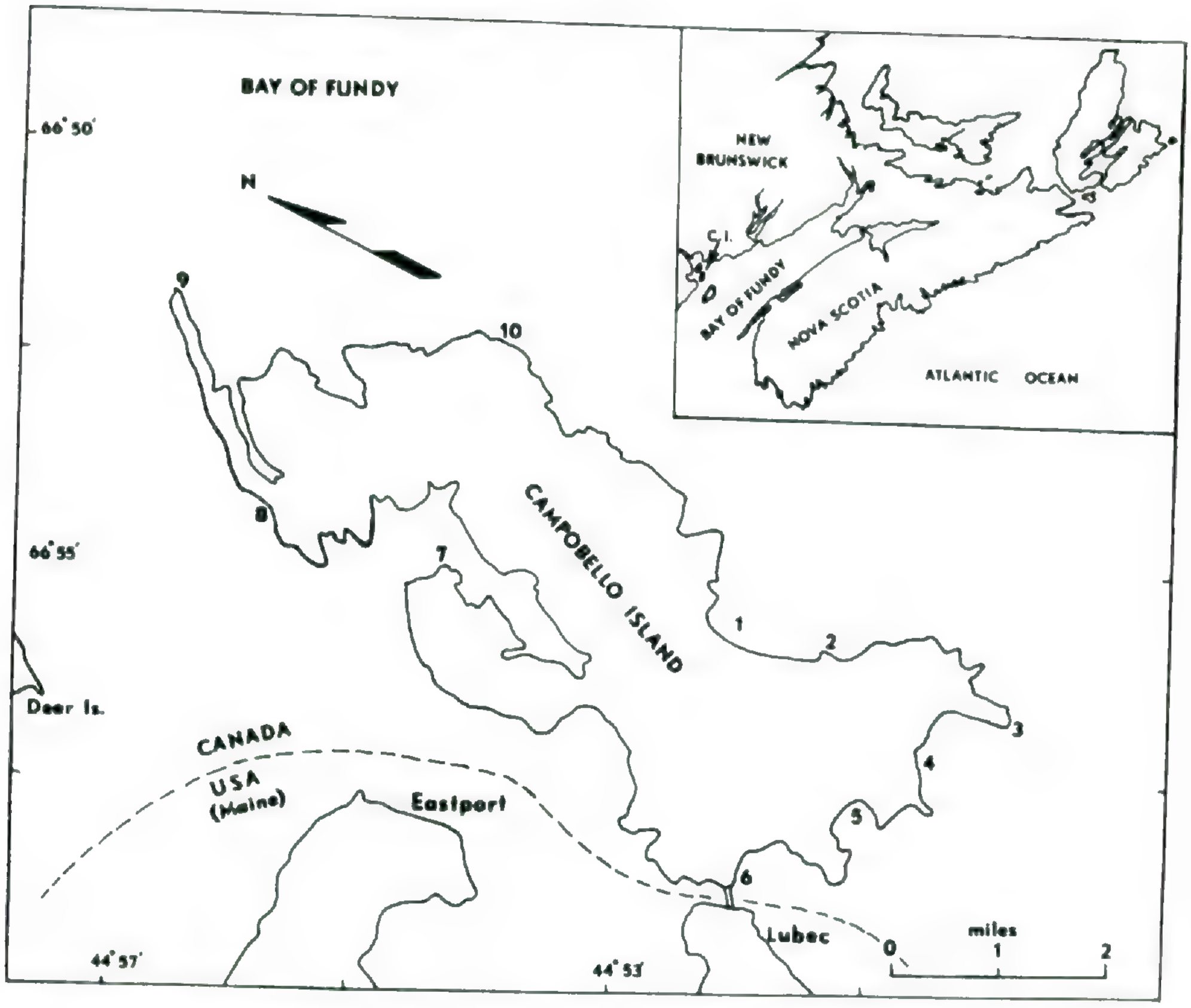

Map of Campobello Island showing locations of collections.

Neck, Bay of Fundy, Nova Scotia, including observations on seasonal changes, vertical distribution and reproductive structures present. Cardinal (1967a, b, c) recorded several new species from New Brunswick and Quebec, and he (Cardinal, 1968) has also given an excellent summarization of the distribution of the marine algae on the east coast of Canada.

Collections and observations of marine algae were made at ten locations (Fig. 1) on Campobello Island, New Brunswick, Canada from May 1966 to May 1969. Table I summarizes the dates and sites of collections. The methods of collection and identification of specimens were similar to those of Mathieson, Hehre and Reynolds (in press) except that most collections were restricted to the littoral zone. The nomenclature of the Second Revised British Checklist

(Parke and Dixon, 1968) has been applied for most taxa, except the Acrochaetiaceae (Papenfuss, 1947). Herbarium voucher specimens of all collections (approximately 1,000) have been deposited in the Algal Herbarium of the University of New Hampshire (NHA). Additional specimens are in the personal herbaria of the authors. The vertical distribution of algae at Campobello Island is described according to the biological classification of Lewis (1964).

Campobello Island is located approximately 1/3 mile offshore from the coastal town of Lubec, Maine, near the boundary of Passamaquoddy Bay and the Bay of Fundy (Fig. 1). The maximum length and width of the Island are approximately 9 by 3 1/2 miles respectively. Much of the Island is covered with marshes and hills. The coast varies from steep granite cliffs to barrier beaches against marshy lowlands. The eastern shore is exposed to the greatest wave action. No major freshwater rivers are evident, and the surface water salinities around the Island are probably uniform. Differences in vegetation are primarily due to physical factors such as wave action, tidal amplitude (average 15-20 feet) and substrate. A brief description of each station is summarized below.

STATIONS

HERRING COVE HEAD (Fig. 1, station 1): An exposed location at the north end of Herring Cove. The substrate consists of steep rock outcrops, which are impenetrable in some places. Many tide pools are present at all levels, and they provide a wide variety of habitats which are not found at any other station except Whiterock Cliffs. Collections were made at Herring Cove Head on most visits to the Island, and these provided a comparison for all other stations.

RACCOON POINT (Fig. 1, station 2): An exposed location at the south end of Herring Cove. It is also designated as Con Robinson's Point or Dinner Head on some maps. The substrate is similar to that at Herring Cove Head, except that the rock outcrops are lower.

LIBERTY POINT (Fig. 1, station 3): An exposed location

on the southern tip of the Island. The substrate is primarily composed of cobbles and small boulders. Few tide pools are present.

GREATER AND LESSER DUCK PONDS (Fig. 1, station 4 and 5): Both locations are sheltered barrier beaches. The substrate is primarily muddy or mud-sand, but cobble and occasional boulders occur near low water. Freshwater stream beds empty into both of the bays. However, the freshwater outfall is limited and it only influences the vegetation in high, marshy areas.

MULHOLLAND'S BEND (Fig. 1, station 6): A muddy area with occasional scattered boulders. It is located under the bridge at the southwest part of the Island. Although the area is protected from wave action it is subject to strong tidal currents. As is typical of other tidal current areas many species of seaweeds are very large in size.

HARBOUR DE LOUTRE (Fig. 1, station 7): A cul-de-sac which is the most sheltered of our stations. The substrate is primarily mud, but occasional cobbles, fish weirs, and one large rock outcrop (Crabble Rock) provide a variety of habitats for seaweeds. Here, as at station 6, many species of seaweeds are very large in size.

WILSON'S BEACH (Fig. 1, station 8): A sheltered shore near the town docks at Wilson's Beach — the only sizeable town on the Island. Collections were made from pier pilings, small scattered rocks and rock outcrops.

EAST QUODDY HEAD (Fig. 1, station 9): A semi-exposed location at the easternmost tip of the Island. The substrate consists of steep rock outcrops.

WHITEROCK CLIFFS (Fig. 1, station 10): An exposed location on the northeast side of the Island. The substrate consists of very steep rock outcrops, many of which are difficult to climb.

A total of 114 taxa of seaweeds were collected at the ten stations, including 32 Chlorophyta, 39 Phaeophyta, 42 Rhodophyta and 1 Xanthophyta. The distribution and seasonal occurrence of each taxa is summarized in Tables II-IV.

The following checklist includes brief comments of noteworthy features.

XANTHOPHYTA

Vaucheria sp.: Found on high, muddy substrates at Great Duck Pond; vegetative.

CHLOROPHYTA

Capsosiphon fulvescens (C. Agardh) Setchell *et* Gardner: On pebbles at Harbour de Loutre.

*__Chaetomorpha aerea__ (Dillwyn) Kützing: Found once (May) at Harbour de Loutre.

Chaetomorpha melagonium (Weber *et* Mohr) Kützing: Common on rocks in the low eulittoral (in tide pools) and sublittoral zones of exposed locations.

Cladophora flexuosa (O. F. Müller) Harvey (= *Cladophora sericeae* (Hudson) Kutzing *sensu* C. van den Hoek, 1963) : Found once on a mud flat at Great Duck Pond.

*__Codiolum gregarium__ A. Braun: Found once (May) on rocks in the high littoral zone; mixed with *C. pusillum*. *Codiolum gregarium* may represent the "sporophyte" generation of one or more local species of *Urospora* (Scagel, 1966).

Codiolum petrocelidis Kuckuck: Endophytic within *Petrocelis middendorfii*. It may be the "sporophyte" generation of *Spongomorpha spinescens* or other local members of the Cladophorales (Scagel, 1966).

Codiolum pusillum (Lyngbye) Kjellman in Foslie: Locally abundant during the winter and spring; mixed with *C. gregarium* in the upper littoral zone. It may also represent the "sporophyte" generation of one or more local species of *Urospora* (see Scagel, 1966).

Enteromorpha erecta (Lyngbye) J. Agardh: Common; free-floating or attached to small stones in the eulittoral zone.

Enteromorpha groenlandica (J. Agardh) Setchell *et* Gardner: Occasional on rocks in the mid eulittoral zone.

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*Within known distributional range, but not previously recorded from New Brunswick.

Enteromorpha intestinalis (L.) Link: Abundant on rocks throughout the eulittoral zone.

Enteromorpha linza (L.) J. Agardh: Common on rocks in the lower eulittoral zone.

Enteromorpha micrococca Kützing: Found once (August) on rocks in the high eulittoral zone.

Enteromorpha minima Nägeli (= *Blidingia minima* (Nägeli *ex* Kützing) Kylin): Occasional on rocks in the high littoral zone.

*__Epicladia flustrae__ Reinke: Endophytic within Sertularians.

Monostroma fuscum (Postels *et* Ruprecht) Wittrock: Locally abundant on rocks and as an epiphyte in the lower eulittoral and sublittoral zones.

Monostroma grevillei (Thuret) Wittrock: Common from late winter to early summer in the mid and lower eulittoral zones.

*__Monostroma leptodermum__ Kjellman: A conspicuous epiphyte on *Zostera marina* during the summer.

Monostroma pulchrum Farlow: Locally abundant on rocks and as an epiphyte in the low eulittoral and sublittoral zones.

Percursaria percursa (C. Agardh) Rosenvinge: Occasional on muddy, marshy substrates in the high littoral zone.

Prasiola stipitata Suhr in Jessen: Occasional on high rocks (splash zone) in exposed and semi-exposed locations.

*__Pseudendoclonium marinum__ (Reinke) Aleem *et* Schulz: Common on rocks in the mid and lower eulittoral zones.

*__Rhizoclonium riparium__ (Roth) Harvey var. **implexum** (Dillwyn) Rosenvinge: Locally abundant on muddy, marshy substrates in the high littoral zone. Usually entangled among other green algae.

Rhizoclonium tortuosum Kützing: Common among various plants in the lower eulittoral zone.

Spongomorpha arcta (Dillwyn) Kützing: Abundant on rocks in the lower eulittoral zone at all stations.

*__Spongomorpha hystrix__ Strömfelt: Found once (May) on rocks in the lower eulittoral zone.
__Spongomorpha spinescens__ Kützing: Locally abundant on rocks in the lower eulittoral (often in tide pool) and sublittoral zones; rarely as an epiphyte.
__Ulothrix flacca__ (Dillwyn) Thuret in LeJolis: Occasional; growing on rocks, muddy surfaces and epiphytic on various algae in the mid and high eulittoral zones.
__Ulva lactuca__ Linnaeus: Common as free-floating masses in muddy areas, or epiphytic on coarse algae in the eulittoral zone. Only occasionally found attached to rocks or pebbles.
__Urospora collabens__ (C. Agardh) Holmes *et* Batters: Occasional on rocks in the upper littoral zone. As suggested by Mathieson, Hehre and Reynolds (in press) *U. collabens* may represent a larger growth form of *U. penicilliformis*.
*__Urospora penicilliformis__ (Roth) Areschoug: Occasional on rocks in the upper littoral zone.
*__Urospora speciosa__ (Carmichael ex Harvey) Leblond *et* Hamel: Our material fits the description given by Edelstein and McLachlan (1966). It occurs commonly on rocks in the mid and upper eulittoral zones, and occasionally epiphytic on coarse algae. Previously recorded from New Hampshire by Mathieson, Hehre and Reynolds (in press).
__Urospora wormskjoldii__ (Mertens) Rosenvinge: Uncommon; on rocks in the lower eulittoral zone.

PHAEOPHYTA

__Agarum cribrosum__ (Mertens) Bory: Common on rocks in the lower eulittoral (tide pools) and sublittoral zones.
__Alaria esculenta__ (L.) Greville (including *Alaria musaefolia* (De la Pylaie) J. Agardh *sensu* Widdowson, 1964): Abundant in exposed locations in the low eulittoral and sublittoral zones. During the winter the specimens are often reduced to residual portions of the stipe.
__Ascophyllum nodosum__ (L.) LeJolis: Ubiquitous throughout the eulittoral zone at all stations.

Chorda filum (L.) Stackhouse: Occasional on small rocks in the lower eulittoral and sublittoral zones; also collected in drift.

Chorda tomentosa Lyngbye: Common on small rocks in the lower eulittoral and sublittoral zones; also collected as free-floating specimens. Several had a larger diameter (over 4 mm) than plants recorded by Taylor (1957).

Chordaria flagelliformis (O. F. Müller) C. Agardh (including var. *densa* Farlow) : Common on rocks, as an epiphyte, and free-floating in the lower eulittoral zone. Frequently associated with *Dictyosiphon foeniculaceus* — particularly at muddy locations.

Cladosiphon zosterae (J. Agardh) Kylin: Found once (August) growing on rocks in the lower eulittoral zone.

Desmarestia aculeata (L.) Lamouroux: Common on rocks in the lower eulittoral (in tide pools) and sublittoral zones.

Desmarestia viridis (O. F. Müller) Lamouroux: Locally abundant on rocks in low tide pools and in the sublittoral zone.

Dictyosiphon foeniculaceus (Hudson) Greville: Common in the lower eulittoral zone; often associated with *Chordaria flagelliformis* as well as epiphytic on the latter plant.

*__Dictyosiphon macounii__ Farlow: Found once (August) at Little Duck Pond.

Ectocarpus confervoides (Roth) Le Jolis: An occasional epiphyte on various coarse algae.

Ectocarpus fasciculatus Harvey: Uncommon; on rocks in the lower eulittoral zone.

Ectocarpus siliculosus (Dillwyn) Lyngbye: Found once (August) as an epiphyte on *Laminaria*.

Elachista fucicola (Velley) Areschoug (including *Elachista lubrica* Ruprecht *sensu* Jassund, 1959) : A common epiphyte on *Fucus* spp. and *Ascophyllum nodosum*; occasionally found on *Halosaccion ramentaceum*.

Fucus distichus L. subsp. **distichus** Powell: Abundant in high tide pools on exposed rocky shores.

Fucus distichus L. subsp. **edentatus** (De la Pylaie) Powell: Locally abundant on rocks in the lower eulittoral zone.

Fucus distichus L. subsp. **evanescens** (C. Agardh) Powell: Distribution is similar to that of subsp. *edentatus*. However, it is more common in muddy habitats than the latter subspecies.

*__Fucus spiralis__ L.: Locally abundant on rocks in the upper littoral zone.

Fucus vesiculosus Linnaeus: Abundant on rocks in the mid and lower eulittoral zones.

*__Fucus vesiculosus__ L. var. **spiralis** Farlow: Common in the mid and upper eulittoral zones of muddy areas.

*__Isthmoplea sphaerophora__ (Carmichael *ex* Harvey in Hooker) Kjellman: Collected once (August) as an epiphyte on Sertularians at Raccoon Point.

Laminaria digitata (Hudson) Lamouroux: Common in the lower eulittoral and sublittoral zones of exposed locations.

Laminaria longicruris De la Pylaie: Occasional in drift.

Laminaria saccharina (L.) Lamouroux *sensu* Wilce, 1965: All of our specimens are the -- ecotype of Wilce (1965) or *Laminaria agardhii* in Taylor (1957). The plants are abundant in the lower eulittoral (in tide pools) and the sublittoral zones.

Leathesia difformis (L.) Areschoug: Found once (August) as an epiphyte on *Chondrus crispus*.

*__Myrionema strangulans__ Greville: An occasional epiphyte on *Ulva lactuca* and *Laminaria saccharina*.

Petalonia fascia (O. F. Müller) Kuntze: Common (especially during spring and summer) throughout the eulittoral zone.

*__Punctaria latifolia__ Greville: Found twice (June and August) as an epiphyte on *Zostera marina*. Mixed with *Monostroma leptodermum*.

Pilayella littoralis (L.) Kjellman: Common on rocks and epiphytic on various algae in the mid and lower eulittoral zones.

*__Ralfsia borneti__ Kuckuck: Occasional on small pebbles in the lower eulittoral zone.

__Ralfsia clavata__ (Harvey in Hooker) Crouan frat.: Found twice (February and June) on small rocks in the lower eulittoral zone.

__Ralfsia fungiformis__ (Gunner) Setchell *et* Gardner: Locally abundant in mid and lower eulittoral tide pools of exposed stations. Plurilocular sporangia were found in February, 1969. Plurilocular sporangia have only been reported once before in North America (Edelstein, Chen and McLachlan, 1968).

*__Ralfsia pusilla__ (Strømfelt) Batters: Found once (October) as an epiphyte on *Chaetomorpha melagonium*. Unilocular sporangia were evident.

__Ralfsia verrucosa__ (Areschoug) J. Agardh: Found once (May) in a mid eulittoral tide pool.

__Sacchoriza dermatodea__ (De la Pylaie) J. Agardh: Locally abundant in low tide pools and in the sublittoral zone during late spring and summer.

__Scytosiphon lomentaria__ (Lyngbye) Link: Common throughout the eulittoral zone at all stations. Several specimens from Mulholland's Bend were larger (i.e. up to 200 cm long) than those recorded by Taylor (1957).

__Sphacelaria cirrosa__ (Roth) C. Agardh: Locally abundant on vertical rock faces which are covered with overhanging fucoids.

*__Spongonema tomentosum__ (Hudson) Kützing: Found once (August) as an epiphyte on the stipes of *Laminaria*.

RHODOPHYTA

__Ahnfeltia plicata__ (Hudson) Fries: Occasional in sandy areas in the lower eulittoral and sublittoral zones.

*__Antithamnion cruciatum__ (C. Agardh) Nägeli: Found once (May) in a low eulittoral tide pool.

*__Antithamnion floccosum__ (O. F. Müller) Kleen: Occasional in tidepools in the lower eulittoral zone.

*__Audouinella membranacea__ (Magnus) Papenfuss: An occasional endophyte in the lorica of Sertularians.

Bangia fuscopurpurea (Dillwyn) Lyngbye: Common on rocks in the upper littoral zone at exposed locations.

***Ceramium deslongchampsii** Chauvin in Duby var. **hooperi** (Harvey) Taylor: Common throughout the year on vertical rock faces under overhanging fucoids.

***Ceramium rubriforme** Kylin, prox.: Found once (August) in the lower eulittoral zone at Little Duck Pond.

Ceramium rubrum (Hudson) C. Agardh: Found three times (May, June and August) in drift.

Chondrus crispus Stackhouse: Locally abundant in the lower eulittoral and sublittoral zones of rocky stations.

Choreocolax polysiphoniae Reinsch: Common as a parasite on *Polysiphonia lanosa*.

***Clathromorphum circumscriptum** (Strømfelt) Foslie: Common in tide pools in the mid and lower eulittoral zones; also abundant in the sublittoral zone.

Corallina officinalis Linnaeus: Common in the lower eulittoral (in tide pools) and sublittoral zones.

Cystoclonium purpureum (Hudson) Batters var. **cirrhosum** Harvey: Common in tide pools and vertical rock faces in the lower eulittoral zone.

***Dermatolithon pustulatum** (Lamouroux) Foslie: Found once (February) as an epiphyte on *Chondrus crispus*.

Dumontia incrassata (O. F. Müller) Lamouroux: Occasional on rocks in the mid eulittoral zone.

Euthora cristata (C. Agardh) J. Agardh: Found once (February) in drift at Raccoon Point.

Gigartina stellata (Stackhouse) Batters: Common on rocks in the lower eulittoral zone.

Halosaccion ramentaceum (L.) J. Agardh: Common to locally abundant in the mid and lower eulittoral zones. Occasionally abundant in high tide pools. As described by Edelstein and McLachlan (1966) its morphology is extremely variable.

Hildenbrandia prototypus Nardo: Common on rocks throughout the eulittoral zone.

***Kylinia secundata** (Lyngbye) Papenfuss: Occasional as

an epiphyte on *Spongomorpha* spinescens and epizoic on Sertularians.

****Lithophyllum corallinae** (Crouan frat.) Heydrich: Uncommon as an epiphyte on *Corallina officinalis*. Previously recorded from Rhode Island to Maine (Taylor, 1957).

Lithothamnium glaciale Kjellman: Locally abundant in the lower eulittoral (in tide pool) and sublittoral zones.

Membranoptera alata (Hudson) Stackhouse: Found occasionally as an epiphyte on *Ptilota serrata*.

Petrocelis middendorfii (Ruprecht) Kjellman: Common on rocks in the lower eulittoral and sublittoral zones.

Peyssonelia rosenvingii Schmitz: Found once (October) growing on *Clathromorphum circumscriptum* in the lower littoral zone.

Phycodrys rubens (L.) Batters: Common in drift; occasional in tide pools in the lower eulittoral zone, and found once at -30 feet.

Plumaria elegans (Bonnemaison) Schmitz: Occasional in the lower eulittoral zone at most rock stations; often on vertical rock faces under overhanging fucoids.

Polyides rotundus (Hudson) Greville: Found occasionally in low tide pools.

****Polysiphonia arctica** J. Agardh: Found once (June) at Whiterock Cliffs. Previously recorded from the arctic to Nova Scotia (as summarized in Taylor, 1957 and Edelstein, McLachlan and Craigie, 1967).

Polysiphonia flexicaulis (Harvey) Collins: Found twice May and August) as drift at Harbour de Loutre.

Polysiphonia lanosa (L.) Tandy: Ubiquitous; hemiparasite on *Ascophyllum nodosum* throughout the mid and lower eulittoral zones.

Polysiphonia urceolata (Lightfoot *ex* Dillwyn) Greville (Including var. *roseola* (C. Agardh) J. Agardh): Common on rocks in the lower eulittoral and sublittoral zones.

***Porphyra leucosticta** Thuret. Found occasionally during the spring and summer in the lower eulittoral and sublittoral zones.

**Range extension and a new record for New Brunswick.

Porphyra miniata (C. Agardh) C. Agardh: Common at most stations in the lower eulittoral and sublittoral zones during the spring and summer. Frequently free-floating and very large in size (over 10 feet in length at Harbour de Loutre).

Porphyra umbilicalis (L.) J. Agardh: Abundant on rocks in the mid and upper eulittoral zones.

*__Porphyra umbilicalis__ (L.) J. Agardh forma __epiphytica__ Collins: Common as an epiphyte on various coarse algae in the mid and lower eulittoral zones.

Ptilota serrate Kützing: Common in drift; occasionally found attached in low tide pools.

Rhodochorton purpureum (Lightfoot) Rosenvinge: Common on vertical rock faces under overhanging fucoids; found once epiphytic on Sertularians.

Rhodomela confervoides (Hudson) Silva: Common in tide pools in the mid and lower eulittoral zones.

Rhodophysema georgii Batters: Found once (August) epiphytic on *Zostera marina*.

Rhodymenia palmata (L.) Greville: Common in the lower eulittoral zone at all stations.

Spermothamnium repens (Dillwyn) Rosenvinge: Found once (June) epiphytic on *Polyides rotundus*.

Of the 114 species of marine algae found on Campobello Island, ten Chlorophyta, nine Phaeophyta and twelve Rhodophyta are new records for New Brunswick. Two of the red algae also represent extensions of known distributional ranges: *Lithophyllum corallinae* was previously recorded from Rhode Island to Maine (as summarized in Taylor, 1957), while *Polysiphonia arctica* was previously known from the arctic to Nova Scotia (as summarized in Taylor, 1957 and Edelstein, McLachlan and Craigie, 1967). Eaton (1873) recorded *Rhodophyllis dichotoma* (designated as *Calliblepharis ciliata*) from Campobello Island, but we have not found it during our study. At present a total of 115 taxa of marine algae are recorded from Campobello Island.

Several additional species (*Eudesme virescens*, *Porphyra umiblicalis* and *Ceramium elegans*) have been reported by

Bell and McFarlane (1933) from the nearby locations of Lubec Harbor and Eastport, Maine. In addition, several other common species (e.g. *Phyllophora brodiaei*, *P. membranifolia*, *Rhodophysema elegans*, *Polysiphonia nigrescens*, *Chaetomorpha linum* and *Punctaria plantaginea*) which are reported from Nova Scotia by Edelstein and McLachlan (1966, 1967a, b) are conspicuously lacking from Campobello. Additional sublittoral observations may reveal some of these species. To date few sublittoral collections have been made, but preliminary observations have revealed a depauperate zone from 0 to 35 feet. Sea urchins *(Strongylocentrotus drobachiensis)* were very conspicuous in the investigated sublittoral zones and the vegetation was restricted to scattered specimens of *Desmarestia* spp., *Agarum cribrosum*, a residual covering of crustose corallines, and a few small algae in cracks and crevices.

An interesting aspect of the study has been the comparative composition of the flora at the various stations. A few preliminary comments can be summarized as follows:

(1) The exposed, rocky shores support the greatest biomass and diversity of species.

(2) Substrate is probably the most important single factor determining the floristic composition at different locations, although exposure to wave action is also an important and highly interrelated factor.

(3) As described by Colinvaux (1966), there is a conspicuous uplifting or emergence of sublittoral organisms on Campobello Island as compared to areas in central-southern New England. For example, *Halosaccion ramentaceum*, *Alaria esculenta* and *Laminaria* spp. are common in the mid intertidal zone (according to the physical delineation of tide levels) at Herring Cove, while they are restricted to the subtidal zone on shores of similar exposure and substrate in New Hampshire (Mathieson, Hehre and Reynolds, in press).

(4) The relatively small number of species found on Campobello Island, as compared to the open Atlantic shores of

Table I. Dates and locations of collections

Stations	20 May 1966	21 May 1966	23 Oct. 1966	4 Feb. 1967	5 Feb. 1967	24 Mar. 1967	14 June 1967	15 June 1967	16 June 1967	17 June 1967	18 May 1968	19 May 1968	5 June 1968	9 Aug. 1968	10 Aug. 1968	11 Aug. 1968	12 Aug. 1968	23 Feb. 1969	17 May 1969	18 May 1969
1. Herring Cove	×	×	×	×				×			×					×		×	×	
2. Raccoon Point				×					×						×				×	
3. Liberty Point									×											
4. Great Duck Pond													×				×			
5. Little Duck Pond													×				×			
6. Mulholland's Bend							×							×						
7. Harbour de Loutre					×	×				×						×			×	
8. Wilson's Beach					×															×
9. East Quoddy Head	×					×								×						×
10. Whiterock Cliffs										×	×									

Nova Scotia, may be due to its relatively sheltered location at the mouth of the Bay of Fundy.

The algal flora of Campobello Island is primarily composed of subarctic and boreal species, but a substantial component of cosmopolitan species is also evident. A comparison of the marine algae from Newfoundland (Mathieson, Dawes and Humm, 1969), Campobello Island and Jaffrey Point, New Hampshire (Mathieson, Hehre and Reynolds, in press) indicates a high degree of similarity between the three areas. Even so there is a higher subarctic component in Newfoundland than at Campobello Island; in turn the boreal and subarctic components are higher at Campobello Island than at Jaffrey Point, New Hampshire. Thus the marine flora of Campobello Island reflects its geographical location.

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Table II. Distribution and Seasonal Occurrence of Chlorophyceae.
The numbers in the columns refer to the stations in Table I.

	J	F	M	A	M	J	J	A	S	O	N	D
Capsosiphon fulvescens			7		7	7						
Chaetomorpha aerea					7							
Chaetomorpha melagonium		2			1, 9, 10	2, 9, 10		1				
Cladophora flexuosa						4						
Codiolum gregarium					1							
Codiolum petrocelidis					1, 2	10		1				
Codiolum pusillum		1			1							
Enteromorpha erecta		2			1, 7, 9	5		2, 5, 6, 7, 9				
Enteromorpha groenlandica					1	4		4				
Enteromorpha intestinalis		1			1, 9, 10	2, 4-7		2, 9, 4-7				
Enteromorpha linza		8			1, 7, 9	2, 3, 5, 6		1, 2, 4, 6, 7, 9				
Enteromorpha micrococca								5				
Enteromorpha minima						1, 10						
Epicladia flustrae					1, 9							
Monostroma fuscum			7		1			1, 4, 5, 6, 9		1		
Monostroma grevillei		8			1, 7, 10	2, 3, 5, 10						
Monostroma leptodermum						5		5, 6				

Table II (cont.)	J	F	M	A	M	J	J	A	S	O	N	D
Monostroma pulchrum					1, 9	1-3, 9, 10						
Percursaria percursa						5		4, 5				
Prasiola stipitata		2, 8			1			2				
Pseudendoclonium marinum		2, 8			1, 7	1, 3		1, 2, 9		1		
Rhizoclonium riparium var. *implexum*						4, 5		4, 5				
Rhizoclonium tortuosum			7		9	4, 5		1, 2, 6, 7, 9		1		
Spongomorpha arcta	1, 2, 8	7			7, 9, 10	1-3, 5-7, 9, 10		1, 2, 4-7, 9, 10				
Spongomorpha hystrix					7							
Spongomorpha spinescens					1, 9	2, 4, 10		1, 2, 4,6		1		
Ulothrix flacca			7		1, 7, 9	9, 10						
Ulva lactuca	1, 2				7, 9	2, 3,						
	8	4			10	5, 6		4, 5				
Urospora collabens					1	9						
Urospora penicilliformis	8				1, 7	10		4, 9				
Urospora speciosa					1, 7	1, 2, 3, 5, 9, 10		4, 9				
Urospora wormskjoldii					1, 2, 10							

Table III. Distribution and Seasonal Occurrence of Rhodophyceae

	J	F	M	A	M	J	J	A	S	O	N	D
Ahnfeltia plicata					1	3						
Antithamnion cruciatum					10							
Antithamnion floccosum		2			10			1, 9				
Audouinella membranacea					9	1, 3, 9, 10						
Bangia fuscopurpurea					1, 9, 10	1, 9, 10						
Ceramium deslongchampsii var. *hooperi*		2, 8			9, 10	3, 9, 10		2				
Ceramium rubriforme								5				
Ceramium rubrum					7	4		9				
Chondrus crispus		1, 2, 7, 8			1, 9, 10	7, 9		1, 2, 6				
Choreocolax polysiphoniae					1	1, 3, 9, 10		1				
Clathromorphum circumscriptum		1, 2	9	1						1		
Corallina officinalis		1			1, 10	1, 2		1, 2, 3, 9, 10		1, 2		
Cystoclonium purpureum var. *cirrhosum*		2			9, 10	1, 2, 3, 9, 10		2, 9				
Dermatolithon pustulatum		1										
Dumontia incrassata			7		1	1, 6, 7						

Table III (cont.)	J	F	M	A	M	J	J	A	S	O	N	D
Euthora cristata		2										
Gigartina stellata		1, 2, 8	7		1	1, 2, 3, 6, 10		1, 2, 6, 7, 9		1		
Halosaccion ramentaceum		1, 2, 8			1, 7, 9, 10	1, 2, 3, 4, 6, 9, 10		1, 5, 6, 9		1, 2		
Hildenbrandia prototypus					1, 2, 7, 8	1, 3		1, 2, 4				
Kylinia secundata					1, 9, 10	10						
Lithophyllum corallinae		1				2				1		
Lithothamnion glaciale		1			1			1, 2, 4				
Membranoptera alata					9, 10	3						
Petrocelis middendorfii					1, 7	1, 2, 9, 10		1, 2				
Peyssonelia rosenvingii										1		
Phycodrys rubens		1, 2			1, 9	3, 10		4		1		
Plumaria elegans		2, 8			10	3		2				
Polyides rotundus					1	3						
Polysiphonia arctica						10						
Polysiphonia flexicaulis					7			7				
Polysiphonia lanosa		1, 2, 8	7		1, 7, 9, 10	1, 2, 3, 9, 10		1, 2, 4, 5, 6, 9		1		
Polysiphonia urceolata		2			1, 7, 9, 10	1, 2, 3, 5, 7, 10		1, 2, 5, 9				

Table III (cont.)	J	F	M	A	M	J	J	A	S	O	N	D
Porphyra leucosticta					9			1, 2, 5, 6, 7, 9				
Porphyra miniata					1, 7, 9, 10	2, 3, 5, 6, 7, 10		1, 2, 4, 5, 6				
Porphyra umbilicalis		1, 2, 8			1, 7 9, 10	1, 2, 3, 6, 10		4, 6, 9		1		
Porphyra umbilicalis f. epiphytica					1	1, 9, 10		1, 2		1		
Ptilota serrata		1, 2			1, 9, 10	1, 3, 5, 9		4		1		
Rhodochorton purpureum	2, 8				1, 10	1, 2, 9, 10		1, 2, 7		1		
Rhodomela confervoides		2			7	1, 2, 3, 5, 7		1, 2, 6				
Rhodophysema georgii								6				
Rhodymenia palmata		1, 2, 8	7		1, 9	1, 2, 3, 6, 7, 9, 10		1, 2, 4, 5, 6, 9		1		
Spermothamnion repens						3						

Table IV. Distribution and Seasonal Occurrence of Phaeophyceae and Xanthophyceae

PHAEOPHYCEAE	J	F	M	A	M	J	J	A	S	O	N	D
Agarum cribrosum		1, 2			1, 9	1, 2, 3, 6, 9, 10		1, 2, 4, 6, 9		1		
Alaria esculenta		1, 2			1, 9	1, 2, 3, 6, 9, 10		1, 2, 4, 6, 9		1		
Ascophyllum nodosum		1, 2,	7		1,9	6, 10		1, 2, 4-7, 9		1		
Chorda filum					1, 7, 9	7		4, 7				
Chorda tomentosa					7, 9, 10	1, 3, 5-7, 9, 10		9				
Chordaria flagelliformis	1, 2		7		1, 7	1-3, 5-7, 9		1, 2, 4, 5, 7, 9		1		
Cladosiphon zosterae								2				
Desmarestia aculeata	1, 2				1, 7	2, 5, 10		1, 2, 5, 9		1		
Desmarestia viridis					1	2, 3, 6, 10		1				
Dictyosiphon foeniculaceus					1, 7	1-7, 9		1-2, 4-7, 9				
Dictyosiphon macounii								5				
Ectocarpus confervoides					10	6		1, 4				
Ectocarpus fasciculatus					1, 7							
Ectocarpus siliculosus								1				
Elachista fucicola						1, 3, 4, 9		1, 2, 4, 5, 7				

Table IV (cont.)	J	F	M	A	M	J	J	A	S	O	N	D
Fucus distichus ssp. *distichus*		1, 2			1, 9	1, 3, 9, 10		1		1		
Fucus distichus ssp. *edentatus*		1, 2			1, 10	1, 2, 3, 6		1				
Fucus distichus ssp. *evanescens*			7		1, 7, 9	3		2, 4-7, 9				
Fucus spiralis		2, 8			1, 9	1, 3, 4, 10		1, 2, 9		1		
Fucus vesiculosus		1, 2, 8	7		1, 9	10		1, 2, 4, 9		1		
Fucus vesiculosus var. *spiralis*			7		7	6		6, 7 2				
Isthnoplea sphaerophora								1		1		
Laminaria digitata	1, 2				1, 7, 9	1, 2 10						
Laminaria longicruris			7		1, 7, 9	7		6, 7				
Laminaria saccharina — ecotype	1, 2, 8		7		1, 9	1-3, 6, 7, 9, 10		1, 2, 4, 5, 6 2			1	
Leathesia difformis						2, 7		4,5				
Myrionema strangulans						1, 2, 5,		1, 2,			1	
Petalonia fascia	8				1, 7, 9	7, 10 5		4, 6 5				
Punctaria latifolia						2-7,		1, 2,			1	
Pilaiella littoralis	1				1, 7, 9, 10	9, 10		4-7, 9				

Table IV (cont.)	J	F	M	A	M	J	J	A	S	O	N	D
Ralfsia borneti		1			1							
Ralfsia clavata		1						4, 5				
Ralfsia fungiformis		1, 2			1, 9	10 1, 9, 10		1		1		
Ralfsia pusilla												
Ralfsia verrucosa					1					1		
Saccorhiza dermatodea						4, 5		1, 2, 6				
Scytosiphon lomentaria	8	7			1, 7, 9	1-7, 9, 10		1, 2, 4-6, 9		1		
Sphacelaria cirrosa	2				10	1, 10		2, 9				
Spongonema tomentosus					1			1				
XANTHOPHYCEAE												
Vaucheria sp.								4				

A LINDEN (TILIA) FOREST ON CAPE COD (WITH EXTENDED NOTES ON TILIA NEGLECTA, BROMUS PUBESCENS, AND RIBES HIRTELLUM).

HENRY K. SVENSON

An extensive area of dunes, known as Sandy Neck, extends for some six miles along the north side of the Cape in the town of Barnstable. It lies between the ocean and the Great Marshes, one of the largest salt marshes in Massachusetts. About halfway down the neck and within the dunes is a swamp hollow with red maples, bordered on its southern bank by a little forest of native linden or basswood trees *(Tilia neglecta)*. There are about a dozen clumps, interspersed among other trees. On the ground is a lush spring growth, a foot or two high, consisting of the grass *Festuca obtusa*, columbine *(Aquilegia canadensis)*, *Geranium maculatum*, *Smilacina stellata*, *Aralia quinquefolia*, and *Thalictrum revolutum*. Less abundant are *Smilacina racemosa*, meadow rue *(Thalictrum polygamum)*, and *Circaea quadrisulcata*. It is reminiscent of the dense herbaceous undergrowth of the Potomac River flats above Washington, but lacks the numerous kinds of violets on those flats. Vines of the small-fruited summer grape *(Vitis aestivalis)* climb high in the trees, but only one vine was seen in fruit, and that far up out of reach.

Some of the ancient maples in the swamp are uprooted and fallen. There are a few willow trees *(Salix Bebbiana)* and a single bush of *Salix cordata*. The middle is practically bare except for dead leaves, the depression extending to a width of about 500 feet. A few bushes of *Ilex verticillata*, with unusually long leaves and solitary fruit, extend into the open area; there are mats of marsh fern and *Lycopus uniflorus* and a few dwarf cinnamon ferns, but no trace of the Massachusetts fern *(Thelypteris simulata)*, abundant in maple swamps at Osterville on the south side of the Cape. Toward the margin are some isolated clumps of sedges and rushes, including *Carex seorsa*, *C. intumescens*,

Juncus effusus var. *solutus*, *J. canadensis*, and *J. tenuis* with extremely narrow leaves.

The north-facing bank, some thirty feet high, is the most interesting area. It has the *Tilia* trees. At the lowest level are marginal and spinulose shield ferns, and some polypody fern. On this bank are sedges, *Carex Swanii*, *C. debilis* var. *Rudgei*, *C. Emmonsii*, and *C. blanda*, the last-named previously known only from Osterville at a locality I cannot find. Toward the entrance to the swamp are a few sparse plants of *Bromus pubescens*, a grass new to southeastern Massachusetts. Of general occurrence are *Trientalis* and Canada mayflower and poison ivy, also common trees of the Cape: black and white oak, tupelo, holly, sassafras, and pitch pines. Witch hazel *(Hammelis)*, scattered flowering dogwood trees (none producing flowers), and the viburnum which passes as *V. venosum* are on the moister parts. The only introduced plant appears to be *Veronica arvensis*, which grows sparingly in little openings.

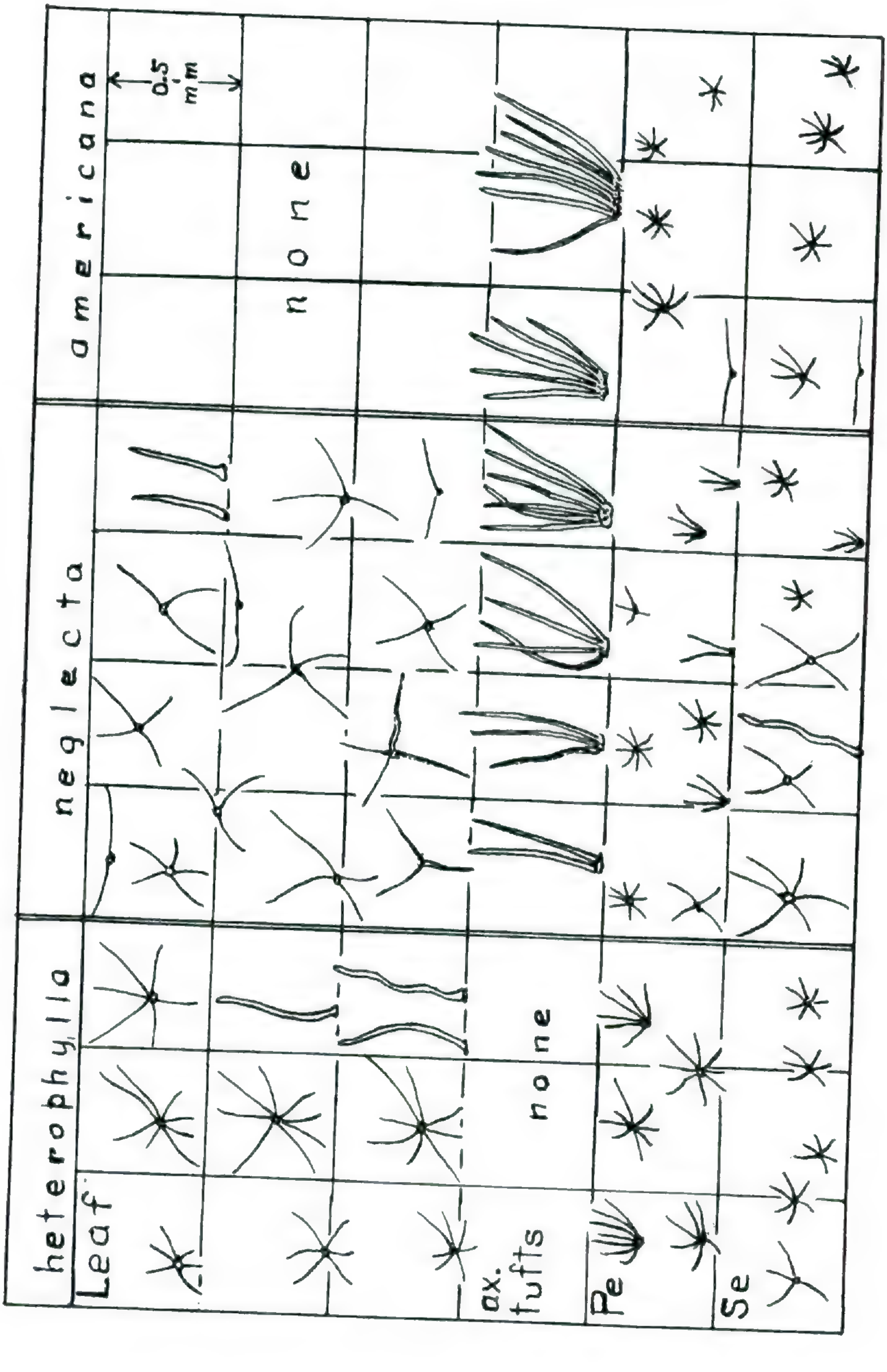
The linden trees are 35 to 60 feet high, each with several trunks 6 to 18 inches in diameter radiating from ground level. Only one clump was flowering. They are *Tilia neglecta*, whatever that name may represent. Spach, in Ann. Sc. Nat. ser. II. **ii:** (1834) pl. 15, gave a detailed account of European and American lindens, including small figures of flower and fruit. *Tilia neglecta* came from "ambulacris Horti Parisiensis" and flowered at the same time as *T. nigra* Borkhausen, *Forstbot.* **2:** 1220 (1803) (synonym of *T. americana* L.), which it resembled in stature, leaves, flowers, and bracts. Spach described the petals as "pallida lutea", and the leaf as "subtus puberula". Fernald, in RHODORA 43: 601-607 (1941), in a review of *Tilia*, said that few collections of *T. neglecta* could be closely matched, that leaves were green or merely grayish beneath with loosely scattered stellate hairs and simple pilosity, and that the series was close to *T. americana*.

In Castanea **20:** 58 (1955), under the new name *T. americana* var. *neglecta*, Fosberg stated that the difference lies in purple twigs and slightly stellulate-pubescent and more

or less glaucous under surfaces of the leaves." He remarks that Little (1953) "has reduced *T. neglecta* outright to *T. americana*, but this seems too drastic." Little was not being drastic; he used a question mark; he was just being careful.

Now there are varietal synonyms that antedate var. *neglecta*. For example, *T. nigra vestita* A. Br. is listed by Rehder, *Man. Cult. Trees* and *Shrubs*, ed. 2: 625 (1940), derived from *T. nigra* β A. Braun in Döll, *Rhein Flora*, p. 674 (1843). By the Austrian J. N. Bayer, in Verhand. Zool.-bot. Ges. Wien 12: (1862) t. VIII, f. 4, *Tilia neglecta* was illustrated from a Spach specimen, showing leaf, foliar bract, and buds; *T. nigra* β was said to be sparingly stellate-pubescent below, cited as coming from Kentucky and cultivated in Europe. It became *T. americana* var. *vestita* (A. Br.) Victor Engler, *Monographie der Gattung Tilia*, Breslau (1909) p. 41. Engler described many forms and varieties, but was not too sure of var. *vestita*, separated with difficulty from the putative hybrid *T. americana* × *heterophylla*. This hybrid, he says, is questionably *T. Michauxii* Nuttall, in which pubescence of the lower leaf surface is greatly reduced. All of which goes to show that the European botanists knew no more about the subject than the American botanists did. Another varietal name to contend with is *T. americana* β *pubescens* Dippel, *Handb. Laubholzkunde* 3: 63 (1893). It was described as having "foliis subtus pilis stellatis ± pubescentes, interdum suborbiculata", and cited from Kentucky *(Short)*, Pennsylvania *(Gray!)*, and Stony Man Mt., Virginia (*Steele* no. 78).

Differences between *T. americana*, *T. heterophylla*, and *T. neglecta* are pretty weak (cf. Rehder, p. 622). In publishing *T. glabra* var. *neglecta*, Bush in *Bull Torr. Cl.* 54: 235 (1927), thought it might be only a form with straight simple firmly-attached pubescence. He cited specimens from coastal Connecticut (Guilford, July and Aug. 1921, *Trelease*). Sargent gave the range of *T. neglecta* (in *Man.* p. 733) as from Montreal to the coast of Massachusetts and New York, through the middle states to the valley of the Potomac River, then west and south. Rehder, the best de-


heterophyllia
Leaf
ax. tufts
Pe
Se
none
none
neglecta
americana
0.5 mm
none

scriber, says leaves are "greenish or grayish and loosely stellate-pubescent beneath, with scattered mostly simple hairs on the veins, often tinged brownish; petals pale yellow and 8 mm. long."

At Sandy Neck the leaves are lightly pubescent below, of firm straight hairs mixed with easily dislodged 2-4-branched flattened hairs. Bud scales and pedicels are moderately stellate (see fig. 2). The flowers are light brown and strong-smelling, and the petals reach 8 × 3 mm, about the size in Spach's figures.

In eastern Massachusetts *Tilia neglecta* appears as a tree of salt marsh islands or associated shores, recorded in the herbarium of the The New England Botanical Club from Mass.: Carr's Island in salt marsh, Newburyport, *Bean*, *Macgregor* & *Knowlton* in 1945; abundant in seashore thicket, Hingham, *Knowlton* in 1943 (ripe fruit); Sampson's Island, Orleans, *Murdoch* in 1913 (no flowers or fruit;

Fig. 1. *Tilia* hair types: lower leaf surface, pedicel, and sepal. Boiled fragments, 1-5 mm in diameter, placed on slide in small drop of glue. Hairs removed with needle; some transferred to 0.5 mm-grid eyepiece on slide.

T. heterophylla, Osterville, July 19, 1969 (no. 2526). Hairs in felt-like flattened layers, 120 on 1 sq. mm, mostly 8-pronged; some unbranched (see fig.). Stellate hairs of petiole and flower bracts in a dense felt-like layer.

T. neglecta, Sandy Neck, July 4, 1969 (no. 2480). Count of flat hairs in a dense area 5 mm square of lower leaf surface: 4-pronged 110 (15%); 3-pronged 30 (5%); 2-pronged 30 (5%); 5-pronged very rare; erect type, unbranched, firmly attached to minute veins, 500 (75%); all these hairs hyaline. Axillary tufts of fascicular hairs: commonly 0.5-0.6 mm long, thickened and brownish. Pedicel: 20 scattered hyaline hairs on 1 sq. mm, chiefly 8-pronged; some fascicled and erect. Sepal: as on pedicel, but dense and felt-like; some erect and sinuous. On flower bract (not shown): small sparse 6-pronged on axial face, larger and 4-6-pronged on abaxial face. Minute scattered reddish glands are along veins on both surfaces of leaf.

T. americana, Milton, July 9, 1969 (no. 3492). Axillary fascicular hairs as in *T. heterophylla*. Pedicel: 20 scattered flat, mostly 8-pronged hairs of varied size. On midrib of leaf bract: some widely scattered flat hairs, mostly 8-pronged. (not shown). On larger veins a few scattered simple hairs (not shown).

noted as the only tree on the island). Conn.: "a large old tree near the coast", leaves and bark collected by Mrs. E. G. Hart. In addition to these citations, I find an old wind-blown tree without flowers or fruit at the entrance (salt marsh) to Dowse's Point, Osterville. I fail to find Fernald and Long's tree "about 7 feet high in 1918" at the mouth of Red River, Harwich, which has leaves loosely matted-stellate below and is maintained as *T. heterophylla* by Fernald and as *T. neglecta* by Sargent. As to other lindens on Cape Cod, there is a flowering tree of *T. heterophylla* on abandoned land on Tower Hill Road, Osterville (no. 2526). It has fragrant pale yellow flowers and thick-felted indumentum on the lower leaf surface. Nearby is a tangle of *Populus alba*, high-climbing *Celastrus orbiculata*, and bushes of honeysuckle *(Lonicera Morrowii)*, three of the commonest introduced and escaped woody species on Cape Cod. *T. americana* is frequently planted; *T. europaea* is an abundant escape from cultivation. The Sandy Neck trees are in an isolated place, and possibility of hybridization is remote. I have treated only the fringe of the problem, the great complexity of which lies in the southern Appalachians.

We now come to the brome grass. *Bromus pubescens* Muhl. occurs sparingly (only two flowering stems observed) along with *Triosteum*, *Galium circaezans*, and *G. triflorum*. In no. 2481 (July 4, 1969) the leaves are more or less pubescent and sheaths glabrous. In no. 2541 (July 20, 1969) the lowest sheath is pubescent. The flange at leaf apex is in both collections about 1 mm long.

The name *B. pubescens* is taken up with some misgivings, in conformity with Wagnon's treatment in RHODORA 52: 211-215 (1950), but I wonder if other specimens could be found in the Linnaean herbaria at Stockholm or Uppsala, (cf. Stearn's *Species Plantarum* Facsimile, pp. 104, 107, and 114 (1957), which might modify the indefiniteness of the Linnaean Herbarium in London. Comparative distinctions were not drawn as finely in 1753 as at the present, and as Stearn (p. 160) says, "The lens had not become the indispensible tool of systematists in Linnaeus' day and the

metric system of measurements had yet to be invented". It is interesting to note that in vol. 2. p. 72, sketches of *Bromus mollis*, *B. lepidus*, and *B. squarrosus* made by Linnaeus are reproduced. These may provide insight on his ideas of the genus. *Bromus purgans* and *B. ciliatus* were actually described in *Species Plantarum*, and this procedure together with the new specific names, is probably associated with the relatively late acquisition of Kalm's material. There has been a good deal of controversy about *B. purgans* and *B. pubescens*. Fernald (*Man.* p. 72) says the name "purgans" was given because Linnaeus erroneously identified the plant with "Gramen bromoides catharticum" of Feuillée. Linnaeus did not do this; he merely cited the Peruvian *Feuillée* figure as questionable.

We now come to the status of the Sandy Neck material. I could not find the collection cited as *B. latiglumis* (Rhodora 49: 258 (1947), and Seymour in "*Flora of New England*" (1969) does not mention it. *B. pubescens* (*B. purgans*, Man. ed. 8) is known sparingly from the Boston area, but becomes common westward, and was originally described by Pursh from Nuttall's collection on the banks of the Missouri River. It was seen by Pursh growing 5 to 8 feet high in Lambert's garden at Boyton, England. Asa Gray records an amusing visit to Lambert (Letters, vol. 1, p. 111 (1893), "the queerest old mortal I ever set eyes on". Lambert's herbarium was broken up and sold, with consequent disappearance of many of Pursh's plants. The switch of names by Wagnon is perhaps the best solution for stability, since *B. latiglumis* (Shear) Hitchcock appears to be untenable. It was a substitute for *B. altissimus* Pursh (1814), not Gilibert (1792). But McVaugh, Gentes Herbarum 8, fasc. 1 (1941) and others consider as invalid the names published in Gilibert's excessively rare "Excercitia Phytologia" (1792).

The Sandy Neck material (cf. *B. purgans*, Rhodora 43: pl. 670 (1941) has only a slight flange at the sheath apex, as in fig. 8. Branching of the panicle and the leaves resemble *B. nottowayanus* (fig. 1) from eastern Virginia,

which along with *B. latifolius* is included by Radford, Ahles, and Bell under *B. purgans* in "*Manual of the Vascular Flora of the Carolinas*", and the name *B. purgans* var. *latiglumis* Shear shows some question as to the diversity of the two plants under discussion. Is our Cape Cod plant possibly a northern extension of the southern coastal-plain *Bromus nottowayanus*? One interesting thing which Wagnon could not explain is the Linnaean use of the term "crispa" in reference to the panicle of *B. purgans* and *B. ciliata*. In *Philosophia Botanica* (1751) it refers only to leaf margins. In going through the grasses of *Species Plantarum*, I find only two other references: *Poa alpina* var. *β* and *Poa bulbosa*, and I suspect the term refers to large pulvini or similar structures. It came from Scheuchzer, the great forerunner on Linnaeus in sedges and grasses.

Bromus pubescens is cited by Seymour as "uncommon; dry open commonly rocky woods in basic soil", and in Massachusetts south to Norfolk County. It is one of the plants listed from Oak Island, Revere, formerly the most interesting salt-marsh island of the Massachusetts coast (cf. the interesting account by W. P. Rich in RHODORA 4: 87-94 (1902). Probably nothing of botanical interest remains.

Festuca obtusa Biehler. Known previously from Cape Cod only at Sandwich and Brewster and there sparingly.

Carex seorsa Howe. Known previously from Monomoy (*Weatherby* in 1914), but it abounds in the maple swamp in the Lowell Reservation on Mashpee Pond, and Fogg cites it from Nonamesset (Elizabeth Islands. It is occasional in the Boston area south to Norton in Bristol County, and I have recently found it in Plymouth County at Plympton.

Carex blanda Dewey. Occasional to frequent in the Boston area, south to localities in Bristol County, and known from Nonamesset. At Osterville it was collected in "wet woods" by Fernald and Hunnewell in 1916. The plant is by no means smooth, as the name might imply, and the minutely serrate upper sheath apex is a good means of identification.

Carex intumescens Rudge. The perigynia are 14 × 6 mm; achenes average 5.0 × 3.1 mm and are not rounded at the apex. The plant is therefore typical southern *C. intumescens*.

Cardamine parviflora L. var. **arenicola** (Britt.) O. E. Schulz. A small white-flowered cress, known previously from sandy woods in Bourne, Saconesset (W. Falmouth), and Provincetown.

Aquilegia canadensis L. Fairly abundant and probably dependent on lime content of shells. It is known from scattered plants in Falmouth, Mashpee, and Osterville. Fogg in RHODORA 32: 176 (1930) cites it as one of the species on the morainal hills of the Upper Cape. It is not known from the Elizabeth Islands. "The superficial aspect of this part of the Cape is that generally associated with the Allegheny flora with a slight tinge of the Canadian. This impression is borne out by a study of the plants which occur here, many of which are entirely lacking, or only locally known elsewhere on the Cape. There are well over 150 such plants."

Ribes hirtellum Michx. var. **calcicola** Fernald. In RHODORA 72: (1970), I described the seeds. On Sandy Neck only a single flower was seen on this prickly little bush, associated here with *Triosteum* and *Galium*. It is obviously out of its environment, which is at the borders of brackish inlets, though recently I found it in a meadow in Sandwich with *Habenaria psycodes*. The Cape Cod plant has been somewhat questionably treated as true var. *calcicola*. The type was *Ribes oxyacanthoides* var. *calcicola in* RHODORA 7: 155 (1905), which came from arbor-vitae swamps at the mouth of the Bonaventure River in Quebec, and characterized by leaves softly pubescent beneath. Inland it grows chiefly in wet calcareous soils, as noted by Wiegand and Eames in *"Flora of the Cayuga Lake Basin"* (1926), McVaugh in *"Flora of Columbia County Area, New York"* (1958), and Deam *"Flora of Indiana"* (1940). A detailed account was given by Fernald in "The Varieties of *Ribes hirtellum*", RHODORA 13: 73-76 (1911). Perhaps the best

treatment is Alwin Berger's in N.Y. State Agric. Expt. Sta. (Geneva) Tech. Bull. no. 109 (1924) which says that in *Grossularia hirtella* the leaves of the short lateral shoots are more reniform or orbicular and with a subcordate base; the petals half as long as the sepals, and white, obovate, or with pink nervation; stamens about as long as the sepals. It has been the source of many cultivated strains of gooseberries. Gleason, *Ill. Fl.* 2: 277 (1963) thinks the distinction between *R. hirtellus* and *R. oxyacanthoides* scarcely warrants specific segregation, since intermediate forms with bracts both villous and glandular-ciliate exist.

The Cape Cod specimens show great variance with the generally accepted characteristics. The leaves are villous below, and vary from cuneate to cordate at the base. Flowers are 2 or 3 on a peduncle. Filaments are commonly 6 mm long and exceed the sepals in mature flowers by 1 to 1.5 mm. Sepals are oblong, green, sometimes purple-tinged, obtuse, commonly hirtellous, 3.5-4 × 2 mm. Petals are scarious white, 2.5 mm long, truncate erose at summit and narrowed to the base; styles usually about equalling the sepals, parted 1.5 mm from the base, and lanuginous for half the length. Glands are common on the apices of the branched petiolar trichomes, and sparingly on petioles, bud scales and bract margins. In addition to strong nodular spines, there are usually numerous reflexed prickles 2-7 mm long on the loose white bark of branches. Perhaps Fernald was closer to the mark when he originally described the plant as *R. oxyacanthoides* var. *calcicola*. The Cape Cod material is fairly homogeneous in the characteristics noted. The following collections are cited: among clumps of *Carex prairea*, at head of tide, Bumps River, Osterville (no. 2004, in flower May 27, 1967); dry bank just above tide level, Mashpee River, Mashpee (no. 2242, in flower May 10, 1969); swamps near old tide level, East Sandwich (no. 1988, in flower May 23, 1967).

Rubus Enslenii Tratt. A trailing blackberry with solitary fruits (det. A. R. Hodgdon). He notes that "it is usually found in oak-hickory woods, and is a relatively southern

species of deciduous woodlands." In their treatment of "Rubus in New England", RHODORA 68: 491 (1966) Hodgdon and Steele cite it from Harwich.

Rubus pensilvanicus Poir. (det. A. R. Hodgdon). A blackberry with tall erect canes "often looking like the common *R. alleghaniensis*, but without the characteristic glands amongst the pubescence of the inflorescence". It is cited from Sandwich and Falmouth. *R. alleghaniensis* is cited by Hodgdon and Steele from Falmouth and Martha's Vineyard.

Agrimonia gryposepala Wallr. Common in the Boston area. Known from Lakeville and Rochester in Plymouth County; and occasional in richer woodlands on Cape Cod in Pocasset, Falmouth, Centerville, and East Sandwich.

Galium triflorum Michx. The leaves are six at a node, but stems vary from smooth to slightly scabrous. The plants are not sweet-scented. Known from Harwich, East Brewster, and Provincetown.

Galium circaezans Michx. var. **hypomalicum** Fernald. Common in northern New England, and extending southward into Bristol County. On Cape Cod it is known from West Barnstable and Provincetown; there are only a few plants at Sandy Neck.

Triosteum aurantiacum Bicknell. The horse-gentian is occasional around Boston and extends south to Plymouth. On Cape Cod it is known from Bourne and Sandwich. Along the Sandwich Beach Road I find it growing with dog's-tooth violet *(Erythronium americanum)*, which is here in great abundance, and is the only locality known on Cape Cod. At one time there were scattered plants of *Claytonia virginica*, otherwise not known as native to eastern Massachusetts. Miss Eda M. Roos, of East Sandwich, informs me that at the turn of the century botany classes from Sandwich High School used to go to Town Neck to see these plants. Mr. Weatherby went with her in 1932 to the locality; he collected *Erythronium* but they found no *Claytonia*. The next year Miss Roos sent me a single specimen, now in the Gray Herbarium.

In the *Tilia* woods on Sandy Neck the *Compositae* are disappointing, only *Aster divaricatus* and *Solidago caesia* were noted, both of them widespread on Cape Cod. I shall give an extended account of the *Amelanchier* and *Viburnum* shortly. Since Sandy Neck is part of the Barnstable town lands, it is protected. The little saltmarsh islands along the Massachusetts coast should be searched for *Tilia* and associated plants, and be preserved before they, too, suffer the fate of Oak Island. Some specimens have been placed in the Cape Cod Museum of Natural History and the New England Botanical Club.

OSTERVILLE, MASS. 02655

After writing this report, I talked with County Commissioner Heyworth Backus. He vaguely remembered a family living at the site, but said we should go to see Martha Dickie, of West Barnstable, who knew all about Sandy Neck. She has a good collection of arrowheads, pestles, and axes from Sandy Neck, and mentioned the skeleton of an Indian chief, found buried there. Also, long after the Indians were gone a socially unambitious family took up quarters. They had a dull-witted daughter. She had a suitor who was not so bright. She said she did not have money for a marriage licence. "That's all right", said the suitor, "I'll write up a licence, and we'll take it to the county clerk, and he'll sign it, and it won't cost anything". So he wrote up the licence on a sheet of paper. It was not a success. Both were committed to an institution for the feeble-minded. It is unlikely that this family or the Indians would have planted linden trees in a remote corner of the swamp, and we have already seen that native linden trees are scattered along the Massachusetts coast.

Since I wrote this footnote I have seen Spach's specimens of *Tilia neglecta* at Paris, and *Bromus purgans* in the Linnaean Herbarium in London. They will be commented upon later.

DISTRIBUTIONAL HISTORY OF LYCOPUS EUROPAEUS (EUROPEAN WATER-HOREHOUND) IN NORTH AMERICA[1]

RONALD L. STUCKEY AND W. LOUIS PHILLIPS[2]

Within the past one hundred years, *Lycopus europaeus* has become naturalized in northeastern North America from Europe. Early literature and herbarium records dating as far back as about 1860 indicate that the species was first found on ballast or in waste places in the eastern seaports of Norfolk, Camden, Philadelphia, Wilmington, New York City, and Boston. Since then the species has spread via waterways along the coast and inland where it now occurs along ditches, rivers, canals, lakes, and in marshes and waste places. Small (1933), Fernald (1950), Gleason (1952), and Gleason and Cronquist (1963) report *L. europaeus* as established in waste places and along roadsides on the east coast of the United States from Massachusetts to Virginia, Alabama, Mississippi, and Louisiana, but rarely inland. Henderson (1962) gives its distribution as only from Massachusetts to Virginia. Recent reports of additional locations are North Carolina (Radford, Ahles, and Bell, 1968), Nova Scotia (Erskine, 1951), the St. Lawrence River valley in Quebec (Rousseau, 1968), Ontario (Montgomery, 1957), and the western basin of Lake Erie (Stuckey, 1968). The present known distribution in northeastern North America is given in figure 1.

Lycopus europaeus L., a member of the mint family (Labiatae), occurs outside of North America over most of Europe and into western Asia. Several of its common names are European water-horehound, marsh-horehound, green-archangel, bitter bugle-weed, gipsy-herb, and gipsy-wort. The plants are stout, with stems ranging 0.4-1 meter

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[1]Contribution from the Botany Program (Paper No. 769), the Herbarium, and the Franz Theodore Stone Laboratory, The Ohio State University, Columbus 43210.

[2]Presently in the United States Military Service.

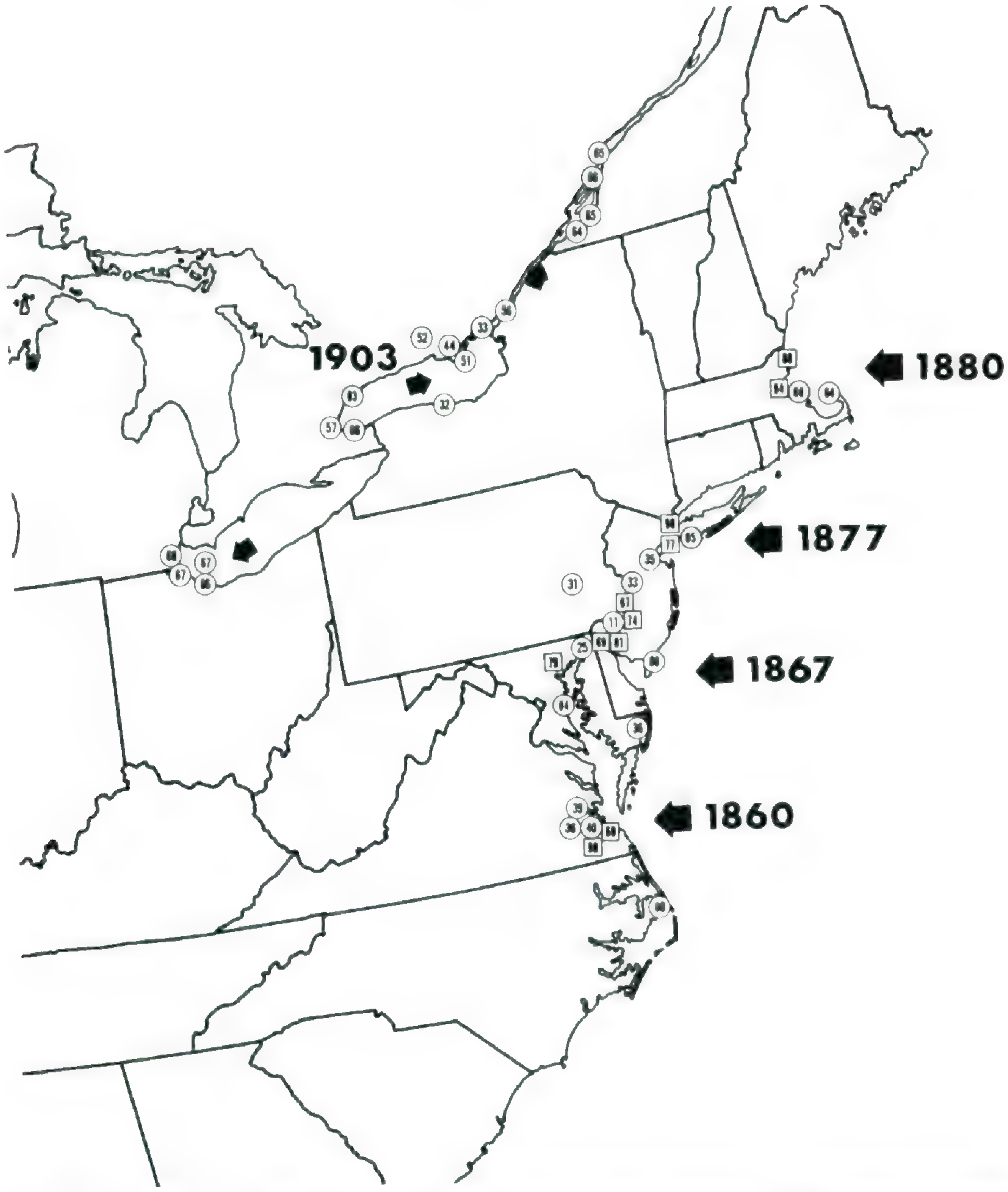

Fig. 1. Known distribution of *Lycopus europaeus* (European waterhorehound) in eastern North America based on herbarium specimens seen and other records cited in this paper. The position of each square or circle represents a locality where a plant has been collected. Numbers in the squares are the last two digits for the year in which the plant was collected if before 1900, and the numbers in circles are the last two digits for the year of collection if since 1900. The oldest known collection is mapped for each locality. The four major areas of apparent entry and establishment for the species in North America are marked by the large black arrows with the date of the earliest known collection for that area. The smaller black arrows indicate the possible migration pattern that the species has taken in the Lake Ontario, St. Lawrence River, and Lake Erie region.

in height, freely branched, and usually pubescent. The leaves are 4-12 centimeters long and 1.5-5 centimeters wide, ovate, ovate-lanceolate, to narrowly lanceolate in general outline with blades sinuately lobed, but not pinnatifid. The white-petaled flowers are somewhat inconspicuous in the axils of the leaves, where later in the year four nutlets are formed each with a heavy corky crest (Henderson, 1962). The species is morphologically very similar to the widespread native American species, *L. americanus*, with which it has often been confused. Characteristics separating the two species are not always well differentiated, and the possibility of hybridization should be investigated. We have neither delimited the character distinctions and possible intermediates between these two species, nor have we attempted to distinguish between typical *L. europaeus* var. *europaeus* and var. *mollis* (Kern.) Briq.

Early Literature Records

One of the difficulties in working out the North American distributional history of *L. europaeus* is that some of the early reports in the literature are considered unreliable because the taxonomy of the genus was not known or understood. For example, the earliest known North American report is by Walter (1788) in his *Flora Caroliniana*. This record has since been referred to *L. americanus* (Henderson, 1962). Bigelow (1824) noted *L. europaeus* for Boston and vicinity. His description, "Lower leaves cut, upper leaves lanceolate, serrate," portrays *L. americanus*, a species which he did not report. Riddell (1834) in his *Synopsis of the Flora of the Western States* listed only *L. europaeus* and *L. virginicus* of which the former is probably the common and widespread *L. americanus*. Gray (1858) reported *L. europaeus* and two varieties, var. *sinuatus* and var. *integrifolius*. These two varieties are currently recognized as *L. americanus* and *L. rubellus*, respectively. Gray's description for *L. europaeus* could be construed to apply to either *L. americanus* or *L. europaeus*: "Stem sharply 4-angled . . . leaves ovate-oblong or oblong-lanceolate, sinuate-

toothed or pinnatifid, more or less petioled . . . nutlets . . . equalling or exceeding the calyx tube." Gray considered typical *L. europaeus* to occur only in Europe. Later, Gray (1867) added a third variety, var. *sessilifolius*, which is currently recognized as *L. sessilifolius*. Gray (1870) revised the taxonomy of *Lycopus* in North America and for the first time recognized the presence of the European species, *L. europaeus*, as an adventive in North America. The reports by Walter (1788), Bigelow (1824), Riddell (1834), and Gray (1858, 1867) have created confusion for later authors. We have discarded these and other erroneous records of *L. europaeus*, all of which are summarized (table 1) along with the probable corrected name for each report and the author(s) who made the correction.

Early Herbarium Records from Virginia, Pennsylvania, and New Jersey

The time and place of introduction of *L. europaeus* in North America is obscure. The earliest known collection (GH, PH) was made by Elias Durand at Norfolk, Virginia, but is without a date. Durand was most active as a plant collector from about 1852 to 1868 (Pennell, 1936). This collection is mapped with the chosen date 1860 (fig. 1). The first known specimen with more adequate data was collected from ballast on Petty's Island in the Delaware River, New Jersey, 1 October 1867 (*Parker s.n.*, GH). These two collections were cited by Gray (1870) as supposedly the first authentic records of *L. europaeus* for North America.

Later records from Virginia come from Norfolk County between Princess Anne and Berkeley, 13 July 1893 (*Heller* 1072, F, GH, MO, NY, PH, US) and "from about wharf" near Suffolk, Nansemond County, 19 July 1898 (*Kearney* 1740, OS, US). By the late 1930's the species apparently had become established and had spread locally as evidenced by collections of M. L. Fernald and Bayard Long from marshes, swales, and roadsides in Nansemond, Isle of Wight, and Surry counties of southeastern Virginia. Their records,

obtained from 1936 to 1941, are summarized in Fernald (1947).

The early records of *L. europaeus* for the Philadelphia area come from ballast as indicated on the labels of plants collected at Camden, New Jersey by C. F. Parker (Petty's Island, 1 October 1867, GH; Kaighn's Point, year 1877, GH; Camden, August 1874, MO, NY, 6 September 1879, PH) and by I. C. Martindale (Camden, August 1876, MO, September 1876, US, July 1877, F). Petty's Island and Kaighn's Point along the Delaware River at Camden and The Ballast Ground at the Navy Yard in Philadelphia were the most prominent locations where ballast of ships was dumped. In papers discussing the occurrence of foreign plants on ballast, Smith (1867), Burk (1877), and Martindale (1877), however, do not list *L. europaeus*. From ballast ground locations, *L. europaeus* apparently spread along the Delaware River where it was later found on the banks and in the marshes from New Castle to Port Penn, Delaware, 8 September 1869 (*Commons s.n.*, NY). Commons also collected it three miles below New Castle (20 August 1874, PH), at Delaware City (5 September 1879, NY), in marshes and along a canal at Delaware City (22 September 1896, PH), along the river shore above Christiana river lighthouse at Wilmington (28 September 1898, PH), and along the river shore at Cherry Island marsh, Wilmington (16 October 1900, PH). A herbarium sheet label by Commons (4 July 1901, PH) bears the note, "now well established along the river shore from Philadelphia to Port Penn and is also common around Salem, New Jersey." The species has continued to spread and become a part of the flora. Forty-five years later, Tatnall (1946) wrote that *L. europaeus* was "common along streams, and on borders of fresh or brackish marshes, Coastal Plain of Cecil [Maryland] and New Castle [Delaware] counties; rare farther south: n. of Ocean City . . . naturalized from Europe." Until 1949, many collections from the eastern Pennsylvania-New Jersey area were deposited in the herbarium of The Academy of Natural Sciences of Philadelphia.

New York and Massachusetts

Most of the early reports for the New York City area list *L. europaeus* as coming from ballast. The earliest known record is 12 July 1877 (*Brown s.n.*, NY). It was later found at 8th Avenue and Harlem River on 4 October 1879 (*Leggett s.n.*, MICH). Brown (1879) listed *L. europaeus* among ballast plants that he found at 8th Avenue and Gowanus in New York City. He also collected a specimen from ballast near Communipaw Ferry [now part of Jersey City], New Jersey in July 1879 (*Brown s.n.*, US). N. L. Britton made a collection from ballast ground at 8th Avenue and 130 Street (September 1879, NY). Plants have also been obtained from ballast at Brooklyn in 1880 (*Schrenk s.n.*, NY), at Yonker's Wool Mill in 1898 (*Bicknell s.n.*, NY), and from Cypress Hills, Long Island, in 1905 (*Bicknell s.n.*, PH). Taylor (1915) reported the European water-horehound as occurring locally rare as a weed in waste places from New York to Virginia and considered it to be naturalized from Europe. House (1924) pointed out that the species was "locally rare as a weed in southeastern New York: naturalized from Europe."

In Massachusetts, John Robinson (1880) mentioned *L. europaeus* as "an adventitious plant and probably does not grow [i.e., is not naturalized] here [Essex County]." European water-horehound was collected on waste ground near Parker Street, Cambridge on 6 October 1894 (*B. L. Robinson s.n.*, GH). Fernald (1910) commenting upon this collection and locality wrote that *L. europaeus* ". . . has grown in waste land and neglected yards about the 'Tin Cañon' in Cambridge for at least sixteen years." The plant was again obtained on Parker Street in a dump on 7 November 1903 (*Moore* 1537a, GH). Fernald (1947) mentioned *L. europaeus* as occasional in waste near Boston. From the apparent lack of records, it seems that *L. europaeus* has spread very little in the Boston area. The most recent known collection for Massachusetts is cited by Seymour (1969). The specimen comes from Provincetown, 17 September 1964 (*Hinds s.n.*, NEBC).

Inland Distribution about Lake Ontario, the St. Lawrence River, and Western Lake Erie

The distribution of *L. europaeus* along Lake Ontario, the St. Lawrence River, and Lake Erie has come about within the past 60-70 years. The first known collection is from Lake Ontario on Toronto Island, York County, 24 August 1903 (*Scott s.n.*, TRT). Succeeding collections have come from Toronto Island, as well as from locations at the east end of the lake by 1933 in the vicinity of Kingston and at the west end of the lake at Hamilton as early as 1957. Montgomery (1957) summarized the distribution of the European water-horehound for Ontario as "Infrequently found around marshes."

The following collections are known from (or near) the shore of Lake Ontario.

NEW YORK: MONROE CO.: Marsh, Irondequoit Bay, 8 August 1932 (*House* 19639, GH); marshy border of bay, Manitou Beach, 15 August 1933 (*House* 20772, GH, NY). ONTARIO: FRONTENAC CO.: Grass Creek Island, 7 mi below Kingston, 18-27 August 1933 (*Pennell* 16226, NY, PH); Eagle Lake, 23 July 1939 (*Krotøkov s.n.*, TRT); opposite grain elevator, Lake Ontario Park, 23 September 1960 (*Beschel, Dore, & Hainault* 11716, DAO). HASTINGS CO.: Edge of water, Belleville, 20 July 1944 (*Groh* 2187, DAO). LEEDS CO.: Plants numerous, swampy spot at mouth of spring among drift-debris, shore of St. Lawrence, 1000-Islands Bridge, 1 August 1956 (*Dore, Soper, & Cody* 16515, DAO); local along shore of St. Lawrence at base of granitic talus, 1000-Islands International Bridge near Ivy Lea, 24 September 1960 (*Dore* 18724, DAO). LINCOLN CO.: Edge of water, Jordan 1 N, 14 September 1966 (*Davidson* 364, DAO). NORTHUMBERLAND CO.: Wooded pasture, Seymour Township, n side of the Trent River near the village of Trent River, 15 August 1952 (*Gillett* 6930, DAO). PRINCE EDWARD CO.: Edge of marsh, ca. 1 mi n of Huff Island, Loc 367, 4 August 1951 (*Soper & Heimburger* 5402, TRT). WENTWORTH CO.: [Between the water and the railway at the extreme west end of Burlington Bay, Hamilton], 5 September 1957, 4983, 4984, 22 July 1958, 4982, 27 August 1958, 4985 (all *A. Tamsalu*, HAM). YORK CO.: Toronto Island, September 1903 (*Wilkes s.n.*, TRT), 18 August 1911 (*White* 1, GH), 20 September 1935 (*Macklin s.n.*, HAM); Harlan's Island, Toronto, 22 August 1945 (*Wage s.n.*, DAO).

The occurrence of *L. europaeus* in the St. Lawrence River valley in the Province of Quebec is very recent. Rousseau

(1968) mapped its distribution based on collections from Valleyfield (1964, *Cinq-Mars s.n.*, QFA), Iles-de-la-Paix, Cté de Beauharnois (1965, *Morency*), Ile St. Ignace, Cté de Berthier (1965, *Rouleau*), and Repentigny (1966, *Rouleau*). These locations and recent dates strongly suggest that the plants are migrating down the St. Lawrence river. Ten years earlier Dore and Gillett (1955) did not find European water-horehound during their botanical survey of the St. Lawrence seaway area upstream in Ontario.

The farthest westward inland penetration for *L. europaeus* appears to be on the islands and about the southwestern shore of the western basin of Lake Erie. Here it was first collected near the camp grounds at Bay Point Peninsula, Ottawa County, on 24 July 1966 (*Easterly s.n.*, BGSU) followed by several collections obtained in 1967 (Stuckey, 1968). The plants occur about the edges of those ponds on the Erie Islands which have connections with the water of the lake, either by a channel or by flooding during violent storms. Elsewhere, its occurrence is along the sandy portions of the shore of the mainland and around the edges of ponds or in marshland directly behind these sandy beaches. The species has not yet penetrated the extensive marshes and mud flats that are common farther inland along the Ohio and Michigan shore of Lake Erie. It is not known whether the species has migrated into Lake Erie from older stations in Lake Ontario or whether it was separately introduced and then began to spread. The local distribution pattern strongly supports the idea that the species (1) has recently invaded western Lake Erie via a water route, rather than coming overland, and (2) is spreading in western Lake Erie by propagules being transported by water. According to Ridley (1930, p. 222), the "plant is specially adapted for dispersal by river, and is very common on English river banks, where it is rapidly dispersed. The nutlets . . . float for from 12 to 15 months (according to Praeger and Guppy)."

L. europaeus is also becoming established in western Lake Erie where it is now known from 11 stations. At several

of these places many young plants have been seen with larger, older individuals of the same species. Many of these young plants are attached to older plants via runners and slender rhizomes. At Terwilliger's Pond on South Bass Island some plants had 5-10 runners ranging up to two feet in length which touched the ground at various places, formed roots, and had initiated new plants. The species is spreading vegetatively at individual sites. At places where disturbance by wave action is considerable, such as at Airport Point and Peach Point on South Bass Island or at Lakeview Park in Port Clinton, *L. europaeus* was not found in 1969, although it was present at these sites in 1967 or 1968. The floras at these sites were drastically altered in 1969 because the unusually higher water level, and wave action had destroyed many of the species along the low rocky and sandy beaches.

The following collections of *L. europaeus* from the western basin of Lake Erie were taken by R. L. Stuckey, unless otherwise noted, and are in The Ohio State University Herbarium (OS) with duplicates elsewhere as stated.

OHIO: ERIE CO.: A few plants on wet sand and gravel dumped in the quarry from the State Park Beach, in the bottom of the northwest limestone quarry below the glacial grooves, Kelley's Island, 14 August 1969, 8238 (CAN, GH, MICH). OTTAWA CO.: Occasional in shallow water at Smith's Pond, s e corner of North Bass Island, 1 August 1967, 4741; Honey Point and Smith's Pond, North Bass Island, 22 August 1969 (*Phillips* 181, OS); South Bass Island — occasional at water's edge along muddy w bank of Terwilliger's Pond, 18 August 1967, 5184 (SMU), 29 August 1967, 5431, Terwilliger's Pond, 20 August 1969, (*Phillips* 180, OS), occasional on thin, wet soil over dolomite rock at Airport Point (opposite Starve Island) on the s e shore, 27 August 1967, 5422; a few plants about boat dock on south shore of Peach Point, Fishery Bay, 24 August 1968, 7499 (DAO); occasional in wet sand behind dune at Sand Point [Bay Point], ca. 2.5 mi s of the town of Marblehead, 8 September 1967, 5716, 12 September 1968, 7685 (CAN, GH, PH); a few plants in ditch along e edge of causeway, East Harbor, East Harbor State Park, 14 August 1968, 7362; occasional on mud flat at e edge of road behind beach at East Harbor, East Harbor State Park, 23 August 1968, 7471, (DAO); East Harbor State Park, 31 July 1969, (*Phillips* 78, OS); a few plants in wet sand at edge of wooded area behind

beach between mud flat formed in previous year, East Harbor, East Harbor State Park, 25 August 1969, 8279; portion from one of four plants seen on wet, sandy beach (not seen here in 1967), NE 1/4 Sec. 5, T6N, R14E, Portage Twp., Lakeview Park, e edge of Port Clinton, 19 August 1968, 7451. LUCAS CO.: Occasional on mud flat along the main driveway at the north edge of Magee Marsh, Crane Creek State Park, Sec. 12, s e corner of Jerusalem Twp., ca. 10 mi e of the town of Oregon, 21 August 1967, 5307; occasional along edge of marsh behind barrier beach, west end of Crane Creek State Park, Magee Marsh, . . . , 27 August 1968, 7541. MICHIGAN: MONROE CO.: Occasional in drying cat-tail marsh near bay of Lake Erie, Sec. 33, Erie Twp., ca. 3.5 mi s e of the town of Erie, 14 September 1968, 7755; occasional in wet sand on beach along shore of Lake Erie, s w corner of Sec. 35, Frenchtown Twp., n edge of Sterling Monroe State Park, e edge of the city of Monroe, 14 September 1968, 7760 (GH).

Unlike the distributional patterns of the non-indigenous *Rorippa sylvestris* (Stuckey, 1966) and *Epilobium hirsutum* (Stuckey, 1970), in which these species apparently migrated inland across central New York State, *L. europaeus* has not been found in central New York State. It appears, therefore, that *L. europaeus* became separately introduced and spread in the Lake Ontario, St. Lawrence River, and Lake Erie waterway independent of its introduction and spread along the east coast of the United States. All of the known localities for the European water-horehound are along the shores of the St. Lawrence river and Lakes Ontario and Erie, except the one from the village of Trent River in Northumberland County, Ontario.

Isolated Occurrences

Several reliable records from isolated locations away from the areas where *L. europaeus* has become established are known. Erskine (1951) reported *L. europaeus* as an adventive species at the edge of a ballast dump, Steele's Pond, Point Pleasant, Halifax County, Nova Scotia, 24 August 1949 (*Erskine & Erskine s.n.*, ACAD). Burk (1961) mentioned the species as occurring at the edge of a freshwater pool, about one half mile from Hatteras lighthouse, Buxton Woods, Hatteras Island, Dare County, North Caro-

lina, 2 September 1960 (*Burk* b55-8, NCU). This is apparently the first record of the species for North Carolina. Radford, Ahles, and Bell (1968) reported it as rare in marshes which are frequently brackish. Along the Gulf of Mexico, *L. europaeus* is known from Cat Island, Harrison County, Mississippi, 11 August 1900 (*Lloyd & Tracy s.n.*, NY). This record was cited by Lloyd and Tracy (1901) and Lowe (1921).

Present Status

In eastern North America *L. europaeus* has become established at several seaport cities and from there has spread locally. The species appears now to be established in six rather well-defined geographical areas. In figure 2, these geographical areas are listed on the vertical axis and time is represented on the horizontal axis. All specimens examined from these areas are each marked with a dot along the horizontal axis at the corresponding five-year interval of collection. This figure shows (1) the earliest specimen record known for each geographical area, and (2) that the species has become established in each geographical area, because specimens have been found and obtained, in the years following the original collection and even up to the present time in certain areas. It can be gleaned from the information in figure 2 that no recent collections are known from the Virginia, Philadelphia, or New York City areas. It seems doubtful that *L. europaeus* has disappeared from these areas where the species has long been established. Rather, this gap in information suggests that collections of plants are not being made in areas that have been rather well-studied in the past. Any flora is continually changing and botanists should continue to keep records and specimens of the flora through time.

Summary

The probable localities and time of introduction and spread of *L. europaeus* in North America have been worked out from the literature and herbarium records. These

sources reveal that many of the early collections came from ballast and waste ground. Its introduction probably was from ships' ballast at several east coast seaports, such as Norfolk, Camden, Philadelphia, Wilmington, New York City, and Boston. From these locations the species appears to have spread locally and became established. Inland, *L. europaeus* is not known from collections before 1900. Since then it has spread and is becoming naturalized as part of the shore flora of the upper portion of the St. Lawrence River, along Lake Ontario, and in southwestern Lake Erie.

Acknowledgments

Our thanks are extended to those herbaria (DAO, GH, HAM, MICH, MO, NEBC, NY, OS, PH, US) whose specimens were examined. Records of herbarium specimens have been provided by Dr. James H. Soper (CAN) and Dr. James Cruise (TRT). The field study in the western Lake Erie area was conducted as part of the teaching and research program at The Franz Theodore Stone Laboratory, Put-in-Bay, Ohio, during the summers of 1967, 1968, and 1969. Additional support for field work has been provided by The Ohio Biological Survey. We are grateful to Mr. Ronnie Johnson, Mr. W. Alan Wentz, and Mr. Thomas Duncan, who served as field assistants.

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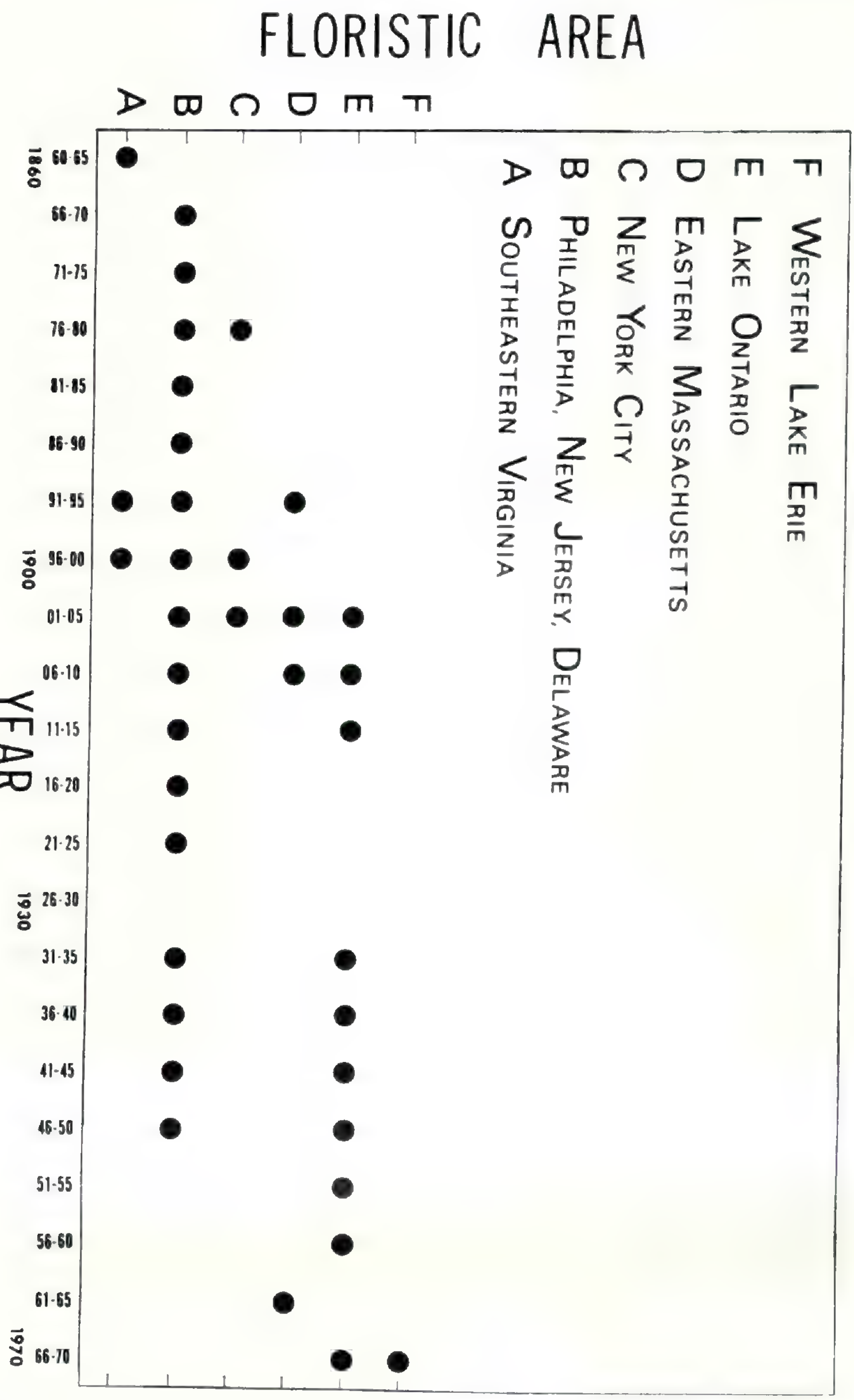

Fig. 2. Dates of herbarium specimens verifying the time of spread and establishment of *Lycopus europaeus* in six floristic areas of eastern North America. Each dot represents one or more herbarium specimens collected within a five-year period for each floristic area.

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TABLE I. MISLEADING PUBLISHED REPORTS OF *L. EUROPAEUS* WITH CORRECTED NAMES

Locality	Published Name	Reference	Revised Name	Reference
Northern United States	*L. europaeus* L. var. *sinuatus* (Ell.) Gray	Gray, 1858, 1867	*L. sinuatus* Ell.	Gray, 1870
Northern United States	*L. europaeus* var. *integrifolius* Gray	Gray, 1858, 1867	*L. rubellus* Moench	Gray, 1870
Northern United States	*L. europaeus* var. *sessilifolius* Gray	Gray, 1867	*L. sessilifolius* Gray	Gray, 1870
Western States	*L. europaeus*	Riddell, 1834	probably *L. americanus* Muhl.	Stuckey & Phillips
Carolinas	*L. europaeus*	Walter, 1788	*L. americanus*	Henderson, 1962
Colorado, San Luis Valley	*L. europaeus*	Rothrock, 1874	probably *L. americanus*	Stuckey & Phillips
Delaware, New Castle County	*L. europaeus* var. *sinuatus*	Tatnall, 1860	*L. americanus*	Stuckey & Phillips
Georgia & South Carolina	*L. europaeus*	Elliott, 1821	*L. americanus*	Weatherby, 1942
Illinois	*L. europaeus* var. *sinuatus*	Patterson, 1876	*L. americanus*	Jones & Fuller, 1955
Illinois	*L. europaeus* var. *integrifolius*	Patterson, 1876	*L. rubellus*	Jones & Fuller, 1955
Illinois, Wabash Valley	*L. europaeus*	Schneck, 1876, 1877	*L. americanus*	Jones & Fuller, 1955
Illinois, Chicago & Vicinity	*L. europaeus*	Babcock, 1872	*L. americanus*	Jones & Fuller, 1955

Locality	Published Name	Reference	Revised Name	Reference
Illinois, Henderson County	*L. europaeus*	Patterson, 1874	*L. americanus*	Jones & Fuller, 1955
Illinois, Piatt County	*L. europaeus* var. *sinuatus*	Seymour, 1883	*L. americanus*	Jones & Fuller, 1955
Illinois, Piatt County	*L. europaeus* var. *integrifolius*	Seymour, 1883	*L. rubellus*	Jones & Fuller, 1955
Indiana, Fayette & Hamilton Counties	*L. europaeus*	Coulter, 1900	*L. americanus*	Deam, 1940
Kansas	*L. europaeus*	Smyth, 1889	probably *L. americanus*	Stuckey & Phillips
Massachusetts, Boston	*L. europaeus*	Bigelow, 1824	probably *L. americanus*	Stuckey & Phillips
Massachusetts, Penikese Island	*L. europaeus*	Jordan, 1874	*L. americanus*	Lewis, 1924
New York, Columbia County	*L. europaeus*	Woodworth, 1839, 1840	*L. americanus*	McVaugh, 1935
Ohio	*L. europaeus* var. *sinuatus*	Beardslee, 1878	*L. americanus*	Stuckey & Phillips
Ohio	*L. europaeus*	Kellerman and Werner, 1893; Kellerman 1899; Kellerman & Kellerman, 1900; Newberry, 1860	probably *L. americanus*	Stuckey & Phillips
Ohio, Miami Valley	*L. europaeus*	Morgan, 1878	probably *L. americanus*	Stuckey & Phillips
Ontario, Prescott	*L. europaeus*	Billings, 1862	*L. uniflorus*	Dore, 1962

SAGA OF THE WEST COAST SEA-ROCKETS: CAKILE EDENTULA SSP. CALIFORNICA AND C. MARITIMA[1]

MICHAEL G. BARBOUR AND JAMES E. RODMAN

The succulent, annual strand plant, *Cakile maritima* Scop.[2] is now common all along the California coast but was first seen there only 35 years ago (Rose, 1936). Prior to that, a presumed native species, *C. edentula* (Bigel.) Hook. ssp. *californica* (Heller) Hult., was the only west coast sea-rocket. *C. maritima* is a Mediterranean plant which has been introduced around the world; *C. edentula* is native to the Atlantic coast of North America (Pobedimova, 1963). Both species have been reported growing intermixed on the west coast strand.

The subspecific rank for the presumed native taxon is not universally accepted. Pobedimova (1963) preferred species rank *(C. californica)*, Fernald (1922) and Schulz (1936) preferred varietal rank *(C. edentula* var. *californica)*, and Hitchcock et al. (1964) preferred to make no distinction at all ("Our material is in no obvious manner different from the plant of the Atlantic coast.")

The senior author has recently investigated the autecology of *C. maritima* (Barbour, 1970a and 1970b) and desired to conduct a comparative study of *C. edentula* ssp. *californica*. The junior author is currently conducting a taxonomic revision of the genus *Cakile*. Both of us desired seed material of *C. edentula* ssp. *californica*, but field trips in 1969 which ranged from Ensenada, Baja California to Birch Bay, Washington convinced us that *C. edentula* ssp. *californica* has become nearly extinct in California while *C. maritima* has enormously increased its range and abundance since its introduction.

Although this apparent, rapid near-extinction seems remarkable, an indirect explanation for it might be that *C.*

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[2]Nomenclature follows Munz and Keck (1959).

edentula ssp. *californica* had never been very common, thus what seems to be a real decline in its abundance has really been of minor proportions. To determine past abundance, we undertook a literature and herbarium survey. Herbaria consulted were: Australia: AD, BRI, CANB, NSW, PERTH; Britain: BM, K; Canada: DAO, UBC; Jamaica: IJ; United States: A, CAS, CU, DAV, DS, DUKE, F, FLAS, FSU, GA, GH, HSC, LA, LAF, LL, MICH, MO, MSC, NCU, NY, ORE, OSC, PH, POM, RSA, SD, SMU, TEX, UC, UCLA, US, USF, WIS. These abbreviations are those of Lanjouw and Stafleu (1964).

The remainder of this paper documents a short but unusual history of successive migrations: the introduction, rise, and fall of *C. edentula* ssp. *californica (californica)* and the introduction and ascendancy of *C. maritima (maritima)*.

The introduction and rise of *C. edentula* ssp. *californica*

At the time *maritima* was first seen on the west coast, some 35 years ago, *californica* was widely distributed from San Diego to Vancouver Island and behaved ". . . like a native . . ." in the strand community (Cooper, 1936). Eyerdam (1938) and Hultén (1968) extended its range even further north to Kodiak Island off Alaska. Because of this wide distribution and supposed taxonomic differences from east coast *C. edentula*, many floras have quietly contended that *californica* is native to the west (*eg.*, Abrams, 1944, Calder and Taylor, 1968, Hultén, 1968, Munz and Keck, 1959, and Peck, 1961). However, botanical explorers of the early 19th century failed to report any *Cakile* on the west coast.

The early North American floras of Hooker (1829-40) and Torrey and Gray (1838-40) record the range of the only *Cakile* listed (= *C. edentula* of today) as being the Atlantic coast and the shores of the Great Lakes, the west coast not being included. It is clear, though, that west coast habitats which support *Cakile* today had been examined, for modern associates of *Cakile* were listed: *eg.*, *Abronia arenaria* Menz. (= *A. latifolia* Eschs.) was said by Hooker

to occur on the ". . . sandy sea-shore, North West America."

Hooker and Arnott (1830-41) reported on the voyage of Captain Beechey, which stopped at Monterey and San Francisco in 1827. *Cakile* was not listed in their flora, but modern associates *Franseria chamissonis* and *Abronia umbellata* were. Torrey's (1875) list of species collected on the voyage of Captain Wilkes in 1838-42 to Washington, Oregon, and northern California does not include *Cakile* but does include modern associates *Abronia arenaria* (= *A. latifolia*), *Franseria bipinnatifida*, *F. chamissonis*, *Lathyrus maritimus*, and *Plantago maritima*.

A relatively detailed collection was made by the Russian Voznesenski along the coast between Bodega Head and Fort Ross, California in 1841 (Howell, 1937). In a personal communication, Howell wrote that *Cakile* was not among the 214 species and varieties which comprised the collection.

As late as 1882, *Cakile* was not on the west coast of Canada, for Macoun's Catalogue of Canadian Plants (1883-1902) did not list it there even though he took care to note that west coast citations were based on his own ". . . very extensive collections . . ." on Vancouver Island and British Columbia in 1875, and on coast trips by Dawson in 1875-9 and Hill in 1880-2. There are no 19th century collections of *Cakile* from the west coast at either Kew or the British Museum of Natural History at which are deposited the collections of such important Pacific coast explorers as Menzies, Scouler, Douglas, Geyer, Burke, Bridges, and Lyall (Thomas, 1969).

In southern California and Baja California, Bentham did not record *Cakile* during his voyage on the H.M.S. Sulphur in 1836-42, but did report associates such as *Abronia umbellata* and *Oenothera cheiranthifolia* (Hinds, 1844). Parry's collections made near San Diego during the boundary survey of 1855-6 (Emory, 1859) did not include *Cakile*; neither did the list compiled by Orcutt (1855) for San Diego County and adjacent parts of Baja California.

Finally, as cited by Jepson (1936), Bolander did not include *Cakile* in his 1870 Catalog of the plants in the San Francisco Bay region, nor did the California Geological Survey of 1876-80 include it. Jepson believed the first report of *Cakile* in California to be by Behr in 1888, of *californica* for a single locality, "Berkeley salt marshes." The earliest west coast collection of *californica* we have seen is dated July, 1882, from the ". . . beach at west-Berkeley . . ." collected by E. L. Greene and deposited at the Gray Herbarium.

If the collections of Bolander in 1870 and the California Geological Survey of 1876-80 are to be accepted as complete, then *californica* was introduced to the west coast in the San Francisco Bay area between 1880 and 1882. And if the west coast taxon is not morphologically distinct from the eastern *C. edentula* — as Hitchcock et al. (1964) contend — then one may guess it was inadvertently transported by ship in wet or dry ballast from the Atlantic coast. The junior author has conducted tests on the effect of sea water on viability of *C. edentula* seeds collected at Cape Cod. Even after immersion in sea water for 10 weeks, washed seeds gave 50-60% germination, suggesting that the seeds could survive for long periods in wet ballast.

From the place of its introduction, *californica* spread rapidly both north and south. Only a few years after its introduction, Greene (1891) reported it as "Common along sandy beaches about the Bay of San Francisco at West Berkeley, Alameda, etc.; also at Half Moon Bay; doubtless not rare on the coast and probably indigenous . . ." Half Moon Bay is about 25 miles south of San Francisco and faces the Pacific. Not long after that, B. L. Robinson, in Synoptical Flora of North America (Gray, 1895-7) listed two species of *Cakile*: *C. maritima* ". . . as ballast weed upon the Atlantic Coast of the Middle States . . ." and *C. americana* Nutt. (=*C. edentula*) on ". . . sea beaches, Gulf of St. Lawrence to Florida; on the Pacific in central California (perhaps introduced), and along the shores of the Great Lakes."

Going north, the earliest Oregon collection seems to be one by J. E. Kirkwood (NY) from the sand dunes at Nestucca in Tillamook County and dated 1901. The earliest Washington collection we have seen is one by E. A. McGregor (DS) from Long Beach in Pacific County, dated 1907. Jones (1936) has previously cited the first Washington collection as being a single plant at Port Angeles, about 650 miles north of San Francisco, in 1908. Jones went on to point out that Piper and Beattie (1915) stated *Cakile* was ". . . very rare . . ." on the northwest coast and cited only two locations for it, Port Angeles and Ucluelet on Vancouver Island. We have seen a collection of *californica* by Macoun (GH, NY) from Ucluelet, British Columbia, dated 1909. Henry (1915) also cited the only location for *Cakile* along the British Columbia coast as being Ucluelet. A few years later, however, Kermode (1921) reported *californica* as being ". . . locally distributed, coast of Vancouver Island."

These herbarium records suggest a progressive northward migration: California, 1882; Oregon, 1901; Washington, 1907; British Columbia, 1909. However, *Cakile* was probably not migrating up the coast as a continuous front; it was probably jumping north considerable distances, then gradually filling in locations south of the northernmost extension. For example, early collections for Oregon are very few in number. The earliest collection for central or southern Oregon we have seen is of *californica* by H. H. Smith (F, NY) from Charleston Bay in Coos Co., dated 1911—yet it had reached Port Angeles at the Canadian border three years before that.

Finally, Hultén (1936) and Eyerdam (1938) reported *californica* on Kodiak Island in 1931—some 2000 miles north of San Francisco and implying a phenomenal rate of migration of 40 miles per year for 50 years. At the present time, *californica* ". . . is a very common species all along the coast of British Columbia . . ." (personal communication, Dr. Roy L. Taylor, University of British Columbia).

To the south, *californica* had reached Corona Del Mar, Orange County, California by 1908 (collection by A. Davidson, ORE) and Ocean Beach, San Diego County by 1906 (collection by K. Brandegee, NY, UC, US). Munz (1935) reported it as present from Santa Barbara to San Diego. Smith (1952) reported it for the Channel Islands of Santa Rosa and San Miguel. According to papers by Greene (1886-7) for Santa Cruz Island, by Brandegee (1888) for Santa Rosa Island, and by Lyon (1886) for Santa Catalina and San Clemente Islands, the Channel Islands did not support *californica* in the late 19th century. In fact, collections by Millspaugh and Nuttall (1923) showed it to be absent from Santa Catalina Island even in the early 20th century. A 1936 collection by Frank F. Gander (SD) showed it to be present at the United States — Mexico border in San Diego County, but apparently it has not penetrated Baja California (Cooper, 1936, Eastwood, 1929, Goldman, 1916, Johnson, 1958).

Within this range, how abundant was *californica*? Information of this sort is scarce in the taxonomic literature, but the following comments have been noted: ". . . occasional . . ." from Santa Barbara to San Diego (Munz, 1936); ". . . scattered . . ." around Santa Barbara and on the islands of Santa Rosa and San Miguel (Smith, 1952) ". . . at the present day no botanist could collect on the ocean strand of San Francisco County without finding *Cakile* [*edentula*] . . ." (Jepson, 1936); ". . . abundant . . ." at the base of Table Bluff in Humboldt County (collection by J. P. Tracy, 1941, UC); ". . . frequent . . ." at Trinidad in Humboldt County (collection by J. P. Tracy, 1948, UC); ". . . this plant is not uncommon on the Washington sea beaches, and in many localities is abundant . . ." (Jones, 1936); ". . . scattered . . ." in Pacific County, Washington (collection by A. N. Steward, 1953, OSC); ". . . widely distributed . . ." from San Diego to Vancouver Island (Cooper, 1936); ". . . common . . ." near Prince Rupert, British Columbia (collection by J. A. Calder, 1954, OSC).

One may conclude that *californica* at the time *maritima*

was first seen in 1935 and for some years after that was very patchy in local distribution, sometimes scattered and sometimes abundant. It was not rare, however, and perhaps the best term to describe its past overall abundance is occasional.

The rise of *C. maritima* and the fall of *C. edentula* ssp. *californica*

The first collection of *maritima* on the west coast was made by Rose (1936) at Stinson Beach, Marin County in May of 1935. Stinson Beach is about 15 miles north of San Francisco. Rose stated the two *Cakile* species were growing intermingled, but he did not comment on their relative abundance. Morphological differences between the two species (having to do with leaf shape, fruit shape, and petal size) are marked and consistent; in our survey we have found few misidentifications, and no misidentifications which produced a *maritima* collection on the west coast prior to 1935.

After 1935, *maritima* appeared to have spread almost as fast as *californica* had before it. In 1937 it was at Salmon Creek, some 40 miles north of Stinson Beach (Baker, 1940); Roxana Ferris described it there as ". . . not uncommon . . ." (1937 collection, GH). Collections by J. P. Tracy revealed that *maritima* reached Humboldt County, 200 or more miles north of Stinson Beach, by 1940: ". . . scattered plants, among other *Cakile* . . ." at Samoa (1940, GH); ". . . a single plant noticed . . ." at the foot of Table Bluff (1941, UC); ". . . introduced there since 1941 . . ." at Centerville Beach (1946, UC); ". . . a very recent introduction . . ." at Trinidad (1948, UC). Peck did not report *maritima* in his first edition of Oregon Flora (1941), but did include it in the second edition (1961) with the comment, "On beaches and young dunes at various points along the coast." The earliest Oregon collection of *maritima* we have seen is one by M. S. Doty from Sunset Bay in Coos County, dated 1942, with the comment ". . . scattered . . ." (DS). The earliest Washington collection we

have seen is one by M. Ownbey and F. G. Meyer from Mukkaw Bay, Clallam County, dated 1940 (DS, GH, UC), but more recently Gilkey and Dennis (1967) have reported *maritima* for sea beaches from Lane County, Oregon to northern Washington. Calder and Taylor (1968) found it on the Queen Charlotte Islands off British Columbia in 1957 — the first published account of it in British Columbia — but a collection by W. Newton in 1951 showed it to be present near Ucluelet some years before that (DAO, UBC). In a personal communication, Taylor added that *maritima* was ". . . rare . . ." all along the British Columbia coast, but judging from herbarium records, it can be locally common (*eg*, collection by J. A. Calder and D. B. O. Savile and R. L. Taylor from one locality in Queen Charlotte Islands in 1957 had the note ". . . common . . .", DAO).

In the south, Roxana Ferris reported *maritima* at Monterey ". . . in large clumps . . . growing with *C. edentula* var. *californica* . . ." (1940 collection, GH). Smith (1952) noted *maritima* to be ". . . locally common . . ." around Santa Barbara but absent from the Channel Islands. Thorne (1967) found *maritima* to be ". . . well-established . . ." on Santa Catalina Island, and Roman Gankin, Botanist for the Davis Botanic Garden, reported it to be ". . . abundant . . ." at the west end of Santa Cruz Island in 1969 (personal communication). Peter H. Raven found it ". . . abundant . . ." on San Clemente Island (1962 collection, SD), and present on San Nicolas Island (1966 collection, SD). Reid Moran noted it as ". . . scarce . . ." as far south as Cédros Island off Baja California (1963 collection, DS, RSA, SD, UC, US).

In less than 30 years, then, *maritima* extended its range about 1000 miles north and south of Stinson Beach — an average migratory rate of 33 miles per year. Although this rate is slower than the 40 miles per year northward rate of *californica* it is still considerably faster than migratory rates of other California weeds. Using the careful records of weed introduction dates and areas of infestation compiled by Robbins (1940, 1952), it is possible to calculate

maximum migration rates for some California weeds. *Hypericum perfoliatum*, for example, migrated 24 miles per year; *Cirsium arvense*, 17 miles per year; *Convolvulus arvense*, 7 miles per year; *Cotula coronopifolia* and *Salsola kali* var. *tenuifolia*, 6 miles per year. Also, the study of *Taeniatherum asperum* (= *Elymus caput-medusae*) by McKell et al. (1962) indicated a migratory rate for that species of 7 miles per year. These weeds are not strand plants, of course, and the more rapid rate of *Cakile* species migration may be due to transport of fruit and seed by ocean currents or by shipping. The junior author has found that upper joints of fruits of *C. edentula* can remain afloat and viable in sea water for 11 days, suggesting that transport by tidal and shore currents is possible. Barbour (1970b) has shown that exposure of *maritima* seeds to even 3% NaCl will not impair subsequent germination if the seeds are washed in distilled water.

Concommitant with the spread of *maritima* has been the decline in abundance of *californica*. The disappearance of *californica* along the California coast has rarely been mentioned in the literature or in herbarium collections. A 1941 collection by R. Bacigalupi (UC) from the San Francisco — San Mateo County Line had the note, "*Cakile maritima* very abundant, *C. edentula* not in evidence." A 1946 collection by J. P. Tracy (UC) from Centerville Beach in Humboldt County had the note, "Introduced there since 1941, but now more abundant than *C. edentula* var. *californica*." Of *californica* for the San Francisco region, Howell et al. (1958) wrote: "No recent collection of this beach plant has been seen."

The most convincing evidence of replacement of *californica* by *maritima* along the California coast comes from recent field visits to sites at which past herbarium collections of one or both species have been made. Our own trips, and recent trips of other Davis botanists allowed us to compile the paired observations summarized in Table 1.

All the 17 sites listed in Table 1 presently support *maritima*, and the abundance of *maritima* ranges from occa-

sional or sporadic (Samoa, San Diego) to abundant (Trinidad, Santa Cruz Island). It must be assumed that *maritima* was absent at all 17 sites prior to 1935, based on our literature and herbarium survey. *Cakile maritima*, then, has enormously increased its range and can generally be described as common along the entire California coast.

Cakile edentula ssp. *californica*, however, has reduced its range. It is probable that *californica* was present at all 17 sites in 1935, but there are definite records of its presence at only 13 sites. Of these 13 sites, it was still present in 1969 at only 2 sites — and in both cases (Trinidad and Table Bluff), only a single plant of *californica* was seen. The change in abundance of the two species is especially dramatic and well documented at Table Bluff: within 28 years, the two exactly reversed their relative abundance.

This replacement of *californica* by *maritima* is apparently not taking place further north. From Ensenada, Baja California, to Fort Bragg, California, we have found only *maritima*, usually abundant and fruiting heavily. In northern California and central Oregon we began seeing scattered individuals of *californica* and noted that *maritima* was less abundant. In northern Oregon and Washington *californica* was predominant, often quite abundant, with a few *maritima* scattered throughout the populations. Plants with hybrid characters are very rare, both in the field and in past herbarium collections, so at this point we hypothesize that hybridization is not occurring; the junior author, however, is at present attempting laboratory crosses.

Conclusions

Neither *Cakile edentula* ssp. *californica* nor *C. maritima* are native to the west coast of North America. *Cakile edentula* ssp. *californica* (perhaps better, *C. edentula*) was introduced between 1880 and 1882 to the San Francisco Bay area, probably by ship from the east coast. It spread as fast as 40 miles per year north to Kodiak Island and south to San Diego. *Cakile maritima* was introduced in

Table 1. Relative abundance of *Cakile edentula* ssp. *californica (calif)* and *C. maritima (marit)* according to past and present collection notes. Items in parenthesis refer to date of past collection, author, and herbarium in which deposited. Note: UCD = DAV.

Location of collection	Past collection notes	Present (1969) collection notes
Stone Lagoon, HUMBOLDT CO., 41°15′	*calif* present (1949, *Nobs and Smith,* UCD); *marit* apparently absent then (no collection seen)	*calif* "absent" and *marit* "occasional" (*Barbour,* UCD)
Trinidad, HUMBOLDT CO., 41°05′	*calif* "frequent" (1948, *Tracy,* UC); *marit* "abundant" (1948, *Tracy,* UCQ)	*calif* "one plant seen" and *marit* "abundant" (*Barbour,* UCD)
Samoa, HUMBOLDT CO., 40°50′	*calif* present (1940, *Tracy,* UC); *marit* "scattered among other *Cakile*" (1940, *Tracy,* UC)	*calif* "absent" and *marit* "occasional" (*Barbour,* UCD, *Rodman,* GH)
Table Bluff, HUMBOLDT CO., 40°40′	*marit* "abundant" (1948, *Tracy,* UC)	*calif* "one plant seen" and *marit* "common" (*Barbour,* UCD)
	marit "only a single plant noticed" (1941, *Tracy,* UC)	
Mouth of Ten Mile River MENDOCINO CO., 39°30′	*calif* possibly present (no collection); *marit* present (1952, *Hemphill,* OSC)	*calif* "occasional to rare" and *marit* "common" (*Barbour,* UCD)
Mouth of Salmon Creek, SONOMA CO., 38°20′	*calif* possibly present (no collection); *marit* "not uncommon" (1937, *Ferris,* GH)	*calif* "absent" and *marit* "occasional" (*Barbour,* UCD)
Bodega Head, SONOMA CO., 38°16′	*calif* present (1932, *Purer,* SD); *marit* "occasional" (1940, *Heller,* UC)	*calif* "absent" and *marit* "occasional" (*Barbour,* UCD)
Dillon Beach, MARIN CO., 38°14′	*calif* possibly present (no collection); *marit* present (1946, *Grant and Grant* UC)	*calif* "absent" and *marit* "occasional" (*Barbour,* UCD, *Rodman,* GH)

Location of Collection	Past collection notes	Present (1969) collection notes
Bolinas, MARIN CO., 37°50′	*calif present* (1926, *Howell*, UC); *marit* absent then	*calif* "absent" and *marit* "occasional" (*Barbour*, UCD)
Stinson Beach, MARIN CO., 37°50′	*calif* present (1935, *Rose* 1936 publ.); *marit* present (1935, *Rose* 1936 publ.)	*calif* "absent" and *marit* "occasional" (*Barbour*, UCD)
Half Moon Bay, SAN MATEO CO., 37°30′	*calif* present (1941, *Rollins*, GH); *marit* "abundant" (1941, *Rollins*, GH)	*calif* "absent" and *marit* "common" (*Barbour*, UCD, *Rodman*, GH)
San Simeon, SAN LUIS OBISPO CO., 35°35′	*calif* present (1946, *Hoover*, CAS); *marit* absent then; (present 1950, *Ferris and Lorraine*, DS)	*calif* "absent" and *marit* "common" (*Rodman*, GH)
Morro Bay, SAN LUIS OBISPO CO., 35°20′	*calif* present (1932, *Purer*, SD); *marit* absent then; (present 1946, *Hoover*, UC)	*calif* "absent" and *marit* "common" (*Gottlieb*, UCD)
Pismo, SAN LUIS OBISPO CO., 35°10′	*calif* present (1920, *Peirson*, RSA); *marit* present (1941, *Reed*, CAS)	*calif* "absent" and *marit* "abundant" (*Rodman*, GH)
Santa Barbara, SANTA BARBARA CO., 34°30′	*calif* "scattered" (Smith 1952 publ.); *marit* "locally common" (*Smith* 1952 publ.)	*calif* "absent" and *marit* "common" (*Gottlieb*, UCD)
Santa Cruz Island, SANTA BARBARA CO., 34°00′	*calif* and *marit* both apparently absent (*Munz* 1935 publ.)	*calif* "absent" and *marit* "abundant" (*Gankin*, UCD)
San Diego, SAN DIEGO CO., 32°35′	*calif* present (1906, *Brandegee*, UC); *marit* present (1954, *Harbison*, UC)	*calif* "absent" and *marit* "sporadic" (*Rodman*, GH)

1935 just north of San Francisco and it has since spread at a rate of about 33 miles per year north to the Queen Charlotte Islands and south to Cédros Island.

At the time *maritima* was introduced the abundance of *californica* could be described as occasional, definitely not as rare. In the past 35 years, however, *maritima* has increased its range and abundance so that it is common all along the California coast, while *californica* has reduced its range and abundance to the point where it may be described as rare in California. It is apparently absent south of Fort Bragg, California, but continues to be common from northern Oregon through British Columbia.

The cause of this near-extinction of *californica* in California is not obvious. Past and present field observations indicate that both species can intermingle on the same beach, hence allelopathy is not indicated. The strand habitat is quite open, with few species and minimal competition from neighboring plants. The strand habitat has probably not experienced a climatic shift during the past 35 years sufficient to affect the growth of these species (although human use of the strand for recreation has increased). It is possible that recently introduced predators or parasites, which have an affinity for *californica* over *maritima* are responsible for the populations shifts, but we have seen no evidence to support that hypothesis.

We have the impression that *maritima* produces more fruit (and seeds) than *californica*. Part of the difference in fruit production may be differences in the degree of branching and length of the racemes, and part may be due to preferential pollination of *maritima* (which has larger petals than *californica*) by insects. The junior author has collected a large variety of bee and fly pollinators from *maritima* flowers. Further north, where *maritima* is not so prevalent, the abundance of pollinators may be less. Early growth chamber experiments conducted by the junior author have shown that both species are self-compatible, but *californica* shows a much higher frequency of successful self-fertilization than *maritima*; hence insect pollina-

tion may be important for *maritima*. If *maritima* does produce more seeds than *californica* in California, and assuming the strand has a limited carrying capacity (see for example Putwain et al., 1968), then *maritima* would eventually displace *californica*.

It may be of some interest and value to continue to follow the abundance of the species in the two regions where they still coexist: the northwest coast of North America and the south coast of Australia (Pobedimova, 1963, Sims, 1968).

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GALINSOGA CILIATA (COMPOSITAE): ITS ARRIVAL AND SPREAD IN THE NORTHEASTERN UNITED STATES

NANCY N. SHONTZ AND JOHN P. SHONTZ

A common weed in the family Compositae, *Galinsoga ciliata* (Raf.) Blake, is a ruderal on both the North American and European continents, probably arriving from South America. The time of its arrival and the rate of its subsequent spread to New England can be estimated with reasonable accuracy from notes in the literature and from information on herbarium sheets. Knowledge of the arrival time of a species into a particular area can be useful in determining evolutionary rates of ecological races (Shontz, 1969).

The history of the species cannot be traced before 1836 when de Candolle separated *Galinsoga parviflora* into two varieties. His *G. parviflora* var. *hispida* is the present-day *G. ciliata*. Also in 1836 Rafinesque described a new genus and species, *Adventina ciliata*, from specimens he found growing in the Bartram Garden of Philadelphia (Blake, 1922). This description is the first record of *G. ciliata* in the United States, but Rafinesque's work was overlooked until 1922. Bicknell (1916), after examining collections from Nantucket Island, Mass., raised *G. parviflora* var. *hispida* to specific rank and renamed the taxon *G. aristu-*

lata. St. John and White (1920) in a review of the genus upheld Bicknell's interpretation. Two years later, Blake (1922) rediscovered Rafinesque's publication and placed Bicknell's *G. aristulata* in synonymy with *G. ciliata*. This treatment is followed in manuals of botany (Fernald, 1950; Gleason, 1952). After studying Mexican and Guatemalan specimens, Turner, Powell and King (1962) concluded that the identifying characteristics which separate *G. ciliata* from *G. parviflora* in the United States and the British Isles might be marked enough to distinguish species in places where the plants have been introduced. In Mexico, however, the differences within the *G. ciliata-parviflora* complex appear to be variations within a single population, and the degree of variation does not exceed that of many widespread weeds.

The species *Galinsoga ciliata* is in the Family Compositae, Tribe Heliantheae, Subtribe Galinsoginae. Plants of *G. ciliata* are usually found growing on patches of bare soil where the ground is frequently disturbed. They are not part of the normal old field succession which occurs if the previously disturbed area is protected from further disruption, since they rarely can compete with taller successional plants which require more than one growing season to become established. Herbarium sheets record its presence at dumps, roadsides, brooksides, sidewalk borders, railway banks, gardens, barnyards, dikes, empty lots, and neglected fields. It often grows in company with species of plantain *(Plantago)*, sorrel *(Oxalis)*, clover *(Trifolium)* and various grasses. Although a relatively recent arrival, *G. ciliata* has acquired at least three common names: Argentine daisy, frenchweed and devilsweed.

Galinsoga ciliata is generally considered to be naturalized from tropical America. Specimens in the Gray Herbarium (Harvard University) were collected in Guatemala (1860), Costa Rica (1891), Mexico (1908), Argentina (1938), Peru (1925) and Chile (1931); the type specimen was collected in Chile in 1790 (photograph examined in Gray Herbarium). After Rafinesque's description of *G. ciliata*, it was

not recorded in New England until 1866 when it was reported from Gilmanton, N.H. (St. John and White, 1920). Another collection in New Hampshire was made at a dumping ground at Milford in 1898 (Wheeler, GH). The plant had extended its range into Maine by 1899 when it was reported in Farmington (Knowlton, GH). In 1902 at Andover, Maine, Rand (1903) reported that it was becoming abundant in gardens, and in 1903 he found it in abandoned gardens at Mount Desert. He felt these two observations indicated a further extension of range by the species. At this time *G. ciliata* was locally abundant, but apparently not widespread or commonly recognized. Knight (1904) collected some from an area in Maine where the straw for packing crockery was commonly dumped and, being unable to identify it, took it to Fernald at the Gray Herbarium for identification. Knight suggested that the plant was introduced in the waste materials; however, previous reports located the plant near the area, so it is more likely the seeds were blown to bare ground in the dumping site. It was collected in Longueuil, Quebec, in 1916 (Fr. M.-Victorin, NY); by 1935 it was living in ten out of twelve streets sampled in Montreal, Quebec (Cléonique-Joseph, 1936), and by 1941 was a common sight in the streets of Halifax, Nova Scotia (Roland, 1941).

To the south it had reached Staten Island by 1873 (Woolson, SCHN) and was collected on Manhattan Island in 1887 (Sterns, GH). It was found in the streets of New Haven in 1886 (Harger, NEBC) and had spread north to Southington, Conn., by 1898 (Andrews, NEBC) where it was collected on cultivated ground. Apparently a recent arrival to waste ground in Providence, R.I. in 1892 (Bailey and Collins, GH), it was collected then but was not mentioned in the state catalog of plants in 1888 (Collins, 1899). Britton and Brown list Rhode Island as the northern extent of this species in 1896. The herbarium sheets of the New England Botanical Club, however, record the collection of *G. ciliata* in 1891 (Fernald) in Cambridge, Mass.; this was followed by several collections from Weston, Boston and Jamaica Plain. The Cambridge specimens appear to

be among the earliest in Massachusetts, although earlier references to *G. parviflora* in the literature may actually refer to *G. ciliata*, as the distinction was often not made at this time between varieties of *G. parviflora*. By 1900 *G. ciliata* was rated as being "more commonly found" by a botanist in Dedham, Mass. (Rich, 1900). In western Massachusetts it was reported from Stockbridge in 1899 (Hoffmann, NEBC) and from Amherst in 1914 (#28614, MASS). South of New York, a plant of *G. ciliata*, the oldest specimen of this species in thc New York Botanical Garden herbarium, was collected in Baltimore, Md., in 1861 (Canby). Other collections were made at Allegheny City, Pa., in 1869 (Porter, GH), Germantown, Pa., in 1880 (#2577, NY), Camden, N.J., in 1881 (#40600, MASS), Wilmington, Del., in 1881 (Commons, GH), Philadelphia (Greenman, GH) and Berwick, Pa., (Heller, GH) in 1889.

The manner of the introduction of *G. ciliata* into the United States is not definitely known. Except for the report from Gilmanton, N.H. (St. John and White, 1920), the oldest records mentioned above are herbarium specimens from Baltimore, eastern Pennsylvania and New York. This fact, combined with Rafinesque's early description from the Bartram Garden, lends credence to the idea that the weed was introduced from South America to this location in Philadelphia and spread from there. The possibility also exists that *G. ciliata* came to Philadelphia from South America by way of the Kew Gardens. Ruiz and Pavon sent materials from Peru to Kew, and there was also exchange of plants between Kew and the Bartram Garden at this time (L. I. Nevling, Jr., personal communication). Only Gleason and Cronquist (1964) suggest that the plant was introduced along the Gulf Coast between 100 and 150 years ago, as well as at "other times and places", without presenting evidence.

If the herbarium dates may be taken as an indication, *G. ciliata* probably arrived in western Massachusetts close to the end of the nineteenth century and has maintained itself on bare soil in gardens, barnyards and roadsides. While the manner of its arrival is somewhat in doubt, two possibilities present themselves: transport of seeds and

plants to greenhouses and dumps by the agency of man or gradual extension of range by the plant through natural seed dispersal from some original point of entry. Since *G. ciliata* is a weed in greenhouses and nurseries where it grows under benches and in pots with more desirable plants, it may have been introduced into one or more greenhouses with plants imported from South or Central America or from the Bartram Garden, and have escaped outside in discarded soil. Several collectors have noted its presence in dumps and theorized that it spread from place to place in discarded materials. Certainly the presence of bare ground in dumps encourages the germination of *Galinsoga* seeds, no matter how they arrived. The concentration of collections made around large cities might attest to the human influence in its spread — as man's moving of packing materials or greenhouse stock from city to city — or to the concentration of professional and amateur botanists in the centers of population. The latter seems less likely, since Blake (Ridley, 1930) observed that both *G. ciliata* and *G. parviflora* were at one time growing almost entirely in the vicinity of cities in the eastern United States but were of very rare occurrence in the country towns. Blake also found a similar distribution pattern in England. Range extension over unbroken areas, the other possibility, would have required rapid migration to western Massachusetts from New Hampshire, Connecticut or eastern Massachusetts. Cléonique-Joseph (1936) suggested wind as the primary means of transport. The small hispid seeds may also be caught in hair and feathers of passing animals and be carried to new sites favorable for growth. As *G. ciliata* extended its range, the plants may even have invaded greenhouses through open vents and doors, and have been brought in with unsterilized soil.

The observations of Blake on the concentration of this species around cities support the hypothesis of spread by man's agency rather than movement by other means, since the latter would be marked by the occurrence of *G. ciliata* in the intervening countryside. In England Salisbury (1961) determined that *G. parviflora* spread at a steady

rate, depending on local air currents to aid its movement and to determine the direction of its dispersal. Long-distance dispersal he attributed to transport on human clothing and in garden soil, rather than to the prevailing wind. All these observations suggest that a combination of human and environmental factors contributed to the arrival and rapid establishment of *G. ciliata* in the northeastern United States.

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ASTER PARVICEPS (BURGESS) MACK. & BUSH AND ASTER BRACHYACTIS BLAKE, NEW FOR KANSAS.

While preparing a treatment of the genus *Aster* (Compositae) for Kansas, specimens of two species were examined which have not been previously reported for the state. The range of *Aster parviceps* (Burgess) Mack. & Bush is thus extended west from Missouri and of *Aster brachyactis* Blake, east from Colorado. *Aster vimineus* Lam. is excluded from the flora since previous reports were based on misdeterminations of *Aster pilosus* Willd., *A. simplex* Willd., and *A. parviceps* (Burgess) Mack. & Bush.

Representative specimens of the two species are:

Aster brachyactis Blake. Finney Co.: sandy bank of Arkansas River, 1 mi s Holcomb, 11 Oct. 1968, *Stephens* 29676 (KANU). Morton Co: grasslands by Cimmaron River, 7 mi n, 1/2 e Elkhart, 6 Oct. 1962, *Wilson* 5523 (KSTC).

Aster parviceps (Burgess) Mack. & Bush. Douglas Co.: prairie over sandstone, 1 1/4 mi e, 1 s Baldwin, 14 Oct. 1967, *Johnson* 1187 (KANU). Labette Co.: prairie fence row, 5 mi w Mound Valley, 28 Sept. 1968, *Stephens* 29617 (KANU). Also from: Allen, Anderson, Bourbon, Chase, Coffey, Elk, Greenwood, Linn, Neosho, and Wilson Counties.

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MOCK BISHOP'S WEED IN THE NEW WORLD TROPICS: RANGE EXTENSIONS FOR PTILIMNIUM CAPILLACEUM (UMBELLIFERAE)

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In the course of general collecting in Puerto Rico in the late summer of 1967 I chanced to stop at a roadside site which had a weed flora reminiscent of the southern Coastal Plain of the United States. Route 15 winds south from Cayey in the eastern third of the island until within a few kilometers it crosses the main east-west divide of the island at about 2,000 feet (600 m) elevation. At this point it offers a splendid view of the Atlantic Ocean to the north; and but for the fact that it is enclosed to some extent by bluffs at this point, it would offer a view of the Caribbean Sea to the south as well. *Solanum americanum* Mill., *Verbena bonariensis* L., *Chenopodium ambrosioides* L., *Sida rhombifolia* L., *Borreria laevis* (Lam.) Griseb., *Lycopersicon esculentum* Mill., *Salvia coccinea* Juss., *Rumex crispus* L., *Stachytarpheta jamaicensis* Vahl, *Leonurus sibiricus* L., *Pilea parietaria* (L.) Blume, *Plantago major* L., and a species of *Hypoxis* all testify to the "weediness" of the site, yet while there was cultivated land nearby, there were no signs of human habitation for several hundred yards. Those familiar with the species would say that this is just the sort of place that *Ptilimnium capillaceum* (Michx.) Raf. might be found. The few plants I found were in very bad shape, and the herbarium sheets they made are far from attractive. Nevertheless, there were quite a number of plants, indicating at least a second generation on Puerto Rican soil. This collection (*D'Arcy* 1896) documenting this range extension for the species is deposited at MO and FLAS. Leon (1957) listed it for Cuba but it has not been reported elsewhere in the Antilles.

In the course of checking the identity of the above collection, I came across a herbarium sheet of the same spe-

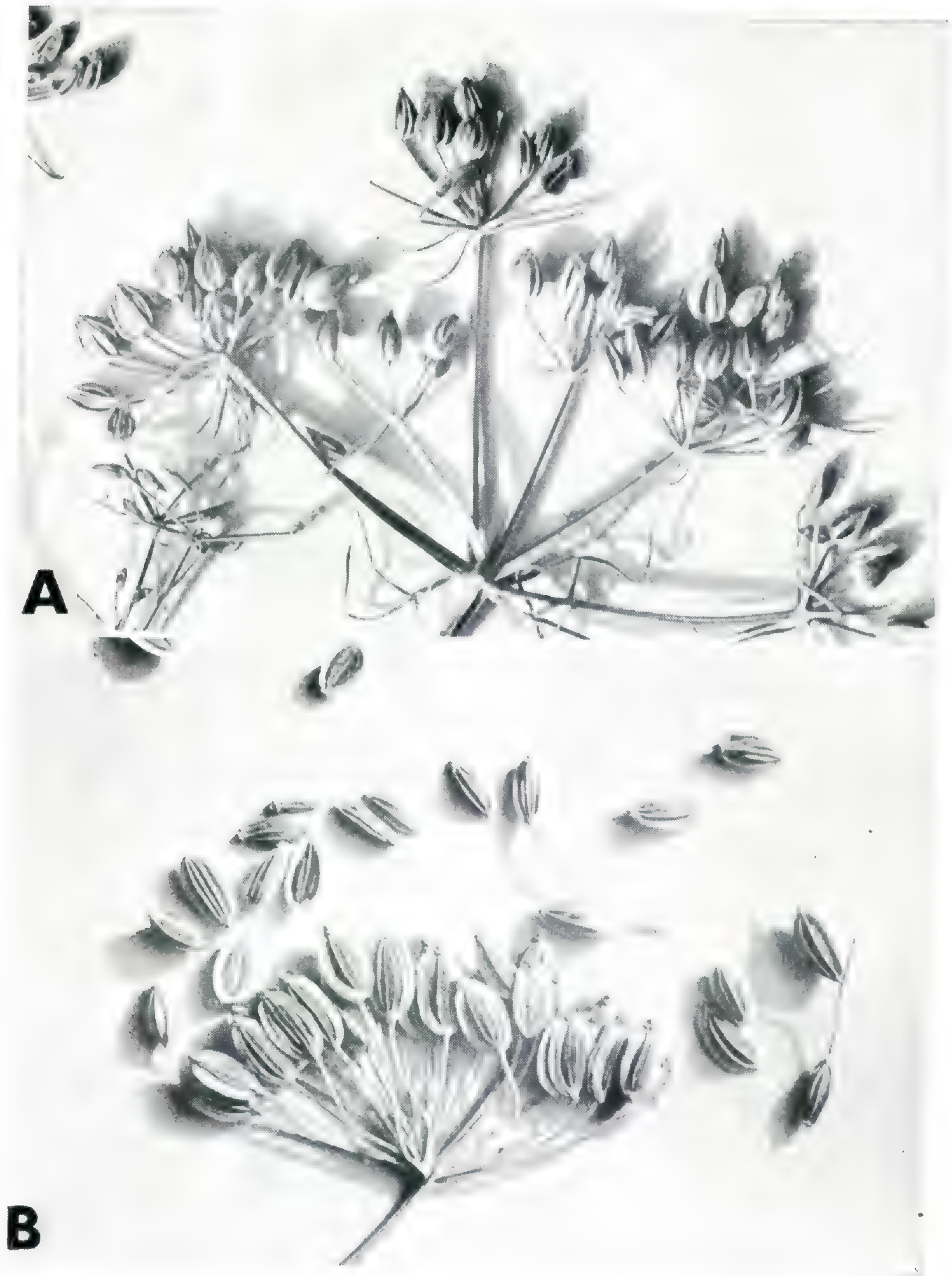

Plate 1. A. Fruits of *Ptilimnium capillaceum* (Michx.) Raf.
B. Fruits of *Anethum graveolens* L.

cies collected in 1967 by Dr. John Dwyer and Sister Mary Victoria Hayden in Panama. Their collection, number 7634, was taken "1.5 miles from Boquete on highway toward David, Chiriquí Province." This specimen, deposited at MO, represents a "first" for the genus in Central America. Dr. William Burger kindly informed me that there are no specimens of *Ptilimnium* among the new large holdings of Central American plants at the Field Museum of Natural History, Chicago.

Finding a number of instances where this species has been confused with *Anethum graveolens* L., "dill," "eneldo," "hinojo," "aneto," or "anisillo," which is sporadically cultivated in the West Indies and Central America has prompted Plate 1 which compares seeds of the two entities. Both Gray's Manual (Fernald, 1950) and Leon (1957) separate them mainly on the fact that *Ptilimniums* have white flowers and *Anethums* have yellow flowers, but this is not always helpful for fruiting material. Not only are the fruits of *Ptilimnium* smaller and plumper, but when the fruit splits in two, the carpophore or central axis usually remains as a distinct peg at the end of the fruit stalk, while in *Anethum* the carpophore splits into two ribs which are sunken in the seed surface and it falls as parts of the two seeds. Also, the seed of *Anethum* is flattened in the direction of the split in the fruit (dorsally compressed) while that of *Ptilimnium* has considerable depth away from the axis of splitting (laterally or not compressed).

The genus *Ptilimnium*, or Mock-Bishop's-weed, includes five other species and was hitherto restricted to the southeastern United States from Massachusetts to Kansas and Texas and south to Florida plus the Leon report for western Cuba. The genus was treated in some detail by Easterly (1957).

In addition to the *Ptilimnium*, the collections of 1967 included several other items worth mentioning. *Oxalis barrelieri* L. was picked up (*D'Arcy* 1720, 1756 FLAS) at two locations on the south side of the island, and Mr. Roy Wood-

bury, who assisted greatly in collecting and in locating my specific "wants" mentioned that it may be becoming common. *Passiflora edulis* Sims (*D'Arcy* 1762 MO) was taken just north of Lake Loiza, and *Verbesina encelioides* Benth. & Hook. (*D'Arcy* 2176 MO), reported as rare by Britton & Wilson (1926), was found to be a very plentiful and conspicuous wildflower throughout the hamlet of La Plena, a dry part of the southern interior of Puerto Rico west of Carmen.

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KALLSTROEMIA IN THE MIDDLE ATLANTIC STATES

DUNCAN M. PORTER

In the course of preparing my monograph of *Kallstroemia*, (Porter, 1969), I saw no collections of the genus from eastern North America from the area east of Illinois and Mississippi and north of South Carolina. Since the manuscript went to press, however, two reports of "*Kallstroemia intermedia* Rydb." have been encountered, one from Maryland (Reed, 1964), and one from Pennsylvania (Wherry, 1968). This name is a synonym of *K. parviflora* Norton.

Through the kindness of Dr. John M. Fogg, Jr., University of Pennsylvania, and Dr. Clyde F. Reed, Baltimore, I was able to examine the specimens cited in these reports. The collection from Maryland [Baltimore Co.: Canton, chrome ore piles, 27 Sept 1953, *Reed* 32745 (Reed Herb.)] proves to be *Kallstroemia parviflora*, while that from Pennsylvania [Delaware Co.: Chester, wharves & railroad sidings, American Dyewood Co., 5 Oct 1932, *Fogg* 5312 (PENN)] is *K. maxima* (L.) Hook. & Arn.

Kallstroemia maxima is a Caribbean species, hitherto known from Colombia and Venezuela northward through Central America, Mexico, and the West Indies to Texas, Florida, Georgia, and South Carolina. *Kallstroemia parviflora*, on the other hand, is a species of central North America, occurring from the Mexican states of Guanajuato, Querétaro, and Hidalgo northward to Colorado, Kansas, Missouri, and Illinois, and from California eastward to Mississippi. Most members of the genus are weedy, and *K. maxima* and *K. parviflora* are commonly encountered in disturbed habitats, both natural and man-made. Also, both species have expanded their natural ranges in historic times. *Kallstroemia maxima* appears to have arrived in the United States via ship's ballast, and the extension of railroads and highways has aided in the spread of *K. parvi-*

flora in North America Ships or airplanes have also played a role in the dispersal of the latter species, conveying it to South America, where it has become a weed in western and central Peru.

It is doubtful if either of these annual species can form persistent populations in the Middle Atlantic States. The winters there should be too severe for survival of their seeds. However, new localities in this area are to be sought, especially along highways and railroads, and on ore and ballast dumps. Weeds of warmer climes are continually being introduced into temperate North America, although few persist to become true members of the flora.

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NEMOPHILA MICROCALYX, AN INCORRECT NAME

JOHN W. THIERET

Rafinesque's much-maligned *Florula Ludoviciana* (Rafinesque, 1817) is essentially an abridged, English and Latin version of Robin's *Flore Louisianaise* (Robin, 1807) (for an eloquent defense of the *Florula* see Shinners, 1957). The *Flore*, an account of the plants observed by Robin during his travels in Louisiana, is arranged according to the Jussieu system and contains descriptions (made, according to Robin, from living plants) and notes on uses and habitat. The plants are referred to largely by French names, but often a Latin generic name or binomial is added. Among the latter are, to quote Rafinesque, "numerous misnames." After studying the *Flore*, Rafinesque "became convinced that a great number of new genera and species" were included therein. He then produced the *Florula*, associating some of Robin's plants with previously published Latin names and supplying new names — 196 specific epithets, 30 generic names — for those he considered undescribed. Most of the new names were validly published. Many of them are, however, later names for the taxa involved. But the epithets for several species are the earliest available. Some of these, in recent years, have been adopted; others, even though correct under the International Code, have not been. One of these concerns us here. *Hydrophyllum trilobum* Raf. has been considered to be a synonym of *H. appendiculatum* Michx., an unfortunate disposition that originated with Asa Gray and that was uncritically followed by Constance (1942), Ewan (1967), and Merrill (1949). Such a disposition is, however, patently untenable on several counts, the most telling being one of geography. *Hydrophyllum appendiculatum* is known to approach no closer than about 250 miles to Louisiana, and so it is most unlikely that this species was seen there by Robin. Additionally, Rafinesque's description of the leaves of *H. trilobum* as "trilobis, crenatis" and of the flowers as "white" certainly

does not suggest *H. appendiculatum*. What Louisiana plant, then, fits Rafinesque's protologue? This question is easily answered: unequivocally the species currently known as *Nemophila microcalyx* (Nuttall) Fischer et Meyer, a woodland annual that is widely distributed in the state — especially in the southern portion where Robin did most of his traveling. The Rafinesquian epithet *trilobum* predates by 20 years the Nuttallian epithet *microcalyx* and thus must replace it. The correct name and pertinent synonymy for the species are given below.

Nemophila triloba (Rafinesque) Thieret, comb. nov.
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EVIDENCE FOR THE HYBRID STATUS OF ASTER × BLAKEI (PORTER) HOUSE[1]

RADCLIFFE B. PIKE

The aster known variously as *Aster Blakei*, *A. nemoralis* var. *Blakei* and *A.* × *Blakei* is intermediate between *A. nemoralis* Ait. and *A. acuminatus* Michx. in many ways; see figures 1, 2 and 3. Intermediate plants are encountered within the general ranges of the two species mentioned but often occur where one or the other is not evident. Thus, it has often been considered to be a hybrid of the two but about equally often interpreted as a species. Evidence of the hybrid nature of these populations has been incomplete; one or the other supposed parent is usually absent and there have been few transitional specimens connecting the more median intermediate ones with *A. acuminatus* in particular. Extensive colonies of *A.* × *Blakei* are often found at the edges of bogs, the shores of ponds, and swampy borders of woods, etc., the kinds of areas that are intermediate in wetness between the boreal forest habitat of *A. acuminatus* and the open bogs of *A. nemoralis*. Colonies of the hybrid characteristically are composed of individuals of essentially similar morphological character. The plants are large and showy and vigorous and, therefore, more easily noticed than *A. nemoralis*.

---

[1]Accepted by the University of New Hampshire as a doctoral dissertation.

Figure 1. *Aster nemoralis* Ait.
Note the large number of narrow, closely spaced leaves and the gradation into bracts approaching the solitary flower heads. The ligules are obviously more numerous, larger and more conspicuous than those of *A. acuminatus* in Figure 2. The interconnecting rhizome on the left hand specimens should be noted.

Figure 2. *Aster acuminatus* Michx.

Note the small number of large well-spaced leaves with coarse serrations. The peduncles are bractless and the flower heads have few rather insignificant ligules. Note the extensive rhizome which seems to be still elongating.

Figure 3. *Aster* × *Blakei* (Porter) House

Note the intermediate sized moderately spaced leaves with noticeable serrations. The gradations between bracts and large numbers of reduced leaves throughout the inflorescence can be seen. Note the extensive growth of rhizomes, characteristic of the hybrid.

Because of the abundance of *Aster* × *Blakei*, the striking effect it makes and the essential similarity of the individual plants occupying extensive areas, it is tempting to classify it as a species. As one comes to understand its biological nature as a hybrid, its mode of reproduction and its habitat requirements, there remains the possibility that it is an incipient species.

The intermediate hybrid population between *Aster acuminatus* and *A. nemoralis* has had an interesting nomenclatural history. There is general agreement now that the first name to have been given to the taxon was *Aster nemoralis* var. *Blakei* by Thomas Porter in 1894, the precise date of publication being July 20. Specimens which may be considered as syntypes were cited by Porter from Gilmanton, N. H., *Blake*, 1864 and Mt. Desert Island, Me., *Rand*, 1893. Professor C. H. Peck (1894) also had given a name to the hybrid, *Aster nemoralis* var. *major* about which there has been some confusion concerning the exact date of publication. Professor Fernald (1921) employed Peck's name but quoted Dr. House to the effect that it was unlikely that the actual printing took place before July 1, 1894. It is on this basis that priority now is accorded Porter's name, var. *Blakei*. Dr. Homer House (1919) made the new combination × *Aster Blakei*, giving Porter as the author of the basionym and indicating the Collection "Five Ponds, Herkimer County", which was cited by Peck along with the publication of his var. *major*, as typical. Shinners (1943) followed House in regarding this Aster as a hybrid though pointing out that "*Aster Blakei* is most common in sections where one supposed parent, *A. acuminatus* is rare or unknown". He also gave an accurate listing of the synonomy of the hybrid. Fernald (1950) in Gray's Manual treated the taxon as *Aster Blakei* (Porter) House though he offered the statement . . . "Sometimes called a hybrid of nos. 59 *(nemoralis)* and 61 *(acuminatus)*; rarely associated with either or both, very fertile and uniform and unknown from much of their coincident areas." To typify the name *Aster* × *Blakei* (Porter) House it is necessary to select a

lectotype from collections cited by Porter. These specimens are not present at the Philadelphia Academy of Science Herbarium, where Porter's collections in major part are preserved, nor are they at the Gray Herbarium or the New York State Museum at Albany, or in other well known herbaria. Until such time as they are located, I propose that the specimen cited by House, when he made the new combination *Aster* × *Blakei*, be considered to accurately represent the name: Five Ponds Herkimer Co. New York C. H. Peck, Aug. without number and year. (NYS) This specimen which had been cited along with the description of Peck's *Aster nemoralis* var. *major* as typical has been carefully examined and is indeed an unquestionable example of *A.* × *Blakei*.

Hybridity in various groups of the American asters has received comment for many years by many authors. Wiegand stated (1928) "it was not until this phenomenon was recognized to take place under natural conditions that a number of perplexing taxonomic problems in aster were clarified." Opinions have varied both as to the widespread occurrence of natural hyridization and as to its importance in regard to species validity in *Aster*. (Avers, 1953). Herbaria have been unduly loaded with specimens exhibiting extreme variability many of which could well be of hybrid origin. This would be a natural result when one considers the tendency to collect the unusual or the different, especially when collecting is done on the individual specimen basis rather than that of population sampling. Although the concept of naturally occurring hybridization was an almost essential and compelling concept for the clarification of the taxonomy of the Aster groups, little, if any real proof was presented until the work of Wetmore and Delisle in producing artificial controlled hybrids between *A. novae-angliae* and *A. ericoides* (1939) followed by Avers (1953) in the Heterophylli series. Both cases showed that controlled artificially produced F1, F2 and backcrossed hybrids were frequently identical with collected specimens of perplexing taxonomic standing. What had been a strong

hypothesis now had the validity of experimental proof. The use of the hybrid index for population analyses has confirmed and delineated the occurrence of natural crossing between good species in other groups of asters and in some cases involving whole taxonomic series. (Cronquist, 1949).

Observations of collectors have indicated that *Aster Blakei* when found with one of its putative parents has been more often associated with *A. nemoralis* than with *A. acuminatus*. This could be interpreted as an indication of habitat preference of the hybrid progeny for the open, well-lighted areas occupied by *A. nemoralis* as opposed to the shady protected habitat of the other parent, *A. acuminatus*. On the other hand, this might well have a genetic compatibility basis whereby backcrossing and hence introgression may occur more readily or successfully in the direction of one parent than the other, in this case in the direction of *A. nemoralis*. This latter explanation also seems to be supported by field and herbarium data. It is a significant fact that *A.* × *Blakei* has often been regarded as a variety of *A. nemoralis* with sometimes suggestions of hybridity with *A. acuminatus* but that no collector of record has indicated that this aster might be a variety of *A. acuminatus*. The greater number of specimens in herbaria which more nearly resemble *A. nemoralis* than *A. acuminatus* is noticeable and population sampling of many colonies confirm this generalization.

On August 22, 1960, an unusual opportunity offered itself to present proof of the hybrid origin of this taxon. While the author and A. R. Hodgdon were on a trip to Outer Wood Island, one of the outlying islands of the Grand Manan archipelago in the Bay of Fundy, they came across a group of asters which was an obvious hybrid swarm between *Aster nemoralis* and *A. acuminatus*. These asters were growing in a narrow, wet, boggy meadow between white spruce and balsam fir woods and a cobble beach. The large pink flowers of *Aster nemoralis* always attract attention, but this group was especially arresting because of the intergrading forms from typical *A. nemoralis* to those ap-

proaching *A. acuminatus*. It was a rainy, foggy, windy, and altogether unpleasant day, and in some haste, specimens were gathered to fill the vasculums. The material was gathered with an eye for diversity yet, more or less, at random. It was probably a fair sampling of the population. Notes made at the end of the day back at the hotel at Castalia on Grand Manan read . . . "Interesting Asters — appears to be × series between *A. nemoralis* and *A. acuminatus* — made a representative collection."

Weatherby and Adams (1945) in their Vascular Flora of Grand Manan reported *Aster acuminatus* as "the commonest aster of the island". For *A. nemoralis* they gave various specific locations "in sphagnum" including White Head Island and Inner Wood Island but not Outer Wood Island; however, since no collections in their list are specifically ascribed to Outer Wood Island, possibly they did not collect there.

In regard to "*Aster nemoralis* var. *major* Peck (var. *Blakei* Porter)", they observe that it "occurs in moist ground at Rich Pond on Ross Island and at Deep Cove (6635) : regarded, quite plausibly, by House and Shinners as a hybrid between *A. acuminatus* and *nemoralis*." They then agree with other observers that "if a hybrid, however, it is an exceptionally common cross, or self perpetuating", still leaving doubt as to its hybridity.

The series of asters collected on Outer Wood Island in 1960 were analyzed by the hybrid index as developed by Edgar Anderson (1936). The use of the hybrid index allows a study of populations where hybridity is suspected and furnishes an analysis that is hardly possible by any other means.

For this particular hybrid index nine characters from the key and species description in Gray's Manual of Botany, 8th Edition, plus one additional character were selected as follows:

1. Number of leaves.
2. Ratio of leaf measurements — length divided by width.

3. Distance in mm. between median internodes.
4. Degree of revoluteness of leaf margins.
5. Degree of scabrosity of leaf margins.
6. Leaf serrations.
7. Number of bracts on peduncles.
8. Number of heads in inflorescence.
9. Ligule color.
10. Zebra hairs.

Phyllary characteristics usually of importance in taxonomic descriptions of asters were omitted because they seemed of little importance as reliable characters within this group but serve rather in distinguishing this group from other American asters.

1. The number of leaves was chosen as an important character because the two presumed parental species are so different in this respect. While *Aster nemoralis* may have one hundred or more leaves, *A. acuminatus* seldom has more than twenty leaves. Accuracy of observation is possible in a numerical character such as this and allows for as many assigned values as the importance of the taxonomic character warrants. Seven values were assigned from 0 to 6 as follows: from 35 leaves to 100 or more = 0, from 34 leaves to 32 = 1, from 31 leaves to 29 = 2, from 28 leaves to 26 = 3, from 25 leaves to 23 = 4, from 22 leaves to 20 = 5, from 19 leaves or less = 6.

A specimen scoring 0 would, in respect to leaf number, be typical of *Aster nemoralis* and a specimen of score 6 would be typical of *A. acuminatus* for this character, the intermediates forming a series, hybrid for this particular character.

2. The ratio of leaf measurements was an obviously important characteristic because of the very different shapes of the leaves of these two asters, those of *Aster nemoralis* being narrow or linear lanceolate while those of *A. acuminatus* are about three times as long as broad. The measurement of leaf length divided by width gives a ratio which expresses the shape and character of the leaf which is of

greater taxonomic significance in distinguishing these two species than any single measurement and the effect of variations in edaphic conditions are at the same time largely eliminated.

Ratios of 10 to 7 were assigned the value of 0 as the leaves of *Aster nemoralis* are from ten to seven times as long as wide. Ratios less than 7 and down to 5 were given the value of 1; of less than 5 and including 4 the value of 2; of less than 4 and down to 3.33 the value of 3; while all lesser ratios were assigned the value of 4. Any specimens having this last value would have leaves not over three times as long as wide which would be typical of *A. acuminatus*. Again, this was a character of real taxonomic importance that allowed accurate observation and division into significant sections.

3. The distance between leaves is diagnostic in describing these two species. The leaves of *Aster nemoralis* are crowded being usually between one and eight millimeters apart while the leaves of *A. acuminatus* are widely spaced, being up to three centimeters apart. The median section of the stem was chosen as the site of measurement to secure truly comparable data. Values were established as follows: 1 to 8 mm. = 0, 9 to 11 mm. =1, 12 to 14 mm. = 2, 15 to 18 mm. = 3, 19 to 23 mm. = 4, 24 to 30 mm. or more = 5.

Admittedly, edaphic conditions could influence these values but it is doubtful if the greatest measurement for *Aster nemoralis* would equal the smallest for *A. acuminatus*. As these values were established for the study of populations where edaphic conditions would be considered somewhat uniform, it was felt that they had sufficient validity.

4. Revolute leaf margin is a strong and constant character of *Aster nemoralis* while flat leaf margin is an equally constant diagnostic feature of *A. acuminatus*. A cursory examination of the specimens to be indexed indicated almost every possible variation of revoluteness and it was obvious that regardless of the desirability of establishing numerous

grades for this important character it would be impossible to accurately classify the material. Hence only four values were established: unquestionable revoluteness with a value of 0 as typical of *A. nemoralis* and unquestionable flatness with a value of 3 as typical of *A. acuminatus* with two intermediate values of 1 and 2.

5. Scabrous leaf margins in *Aster nemoralis* are opposed to hairy margins in *A. acuminatus* and an examination of the material showed a continuous variation that would defy accurate separation into discreet values. Therefore, only the categories scabrous = 0, hairy = 2, and median = 1 were established.

6. The leaves of *Aster nemoralis* are entire while those of *A. acuminatus* are serrate to strongly serrate. The specimens at hand exhibited intermediate conditions but nevertheless separated into four well-marked groups; big serrations, small serrations, presence of a tip gland and not serrate, the latter having the value of 0 for *A. nemoralis* and the value 3 assigned for big serrations as typical of *A. acuminatus*. The presence of the gland having the value of 1 and small serrations 2.

7. The number of bracts on a peduncle presents somewhat of a quandary as in *Aster nemoralis* the leaves grade imperceptibly into bract-like structures, and there is no clear delineation of the peduncle. *A. acuminatus* on the other hand has distinct peduncles which have very few, to no bracts. (In *A.* × *Blakei* the inflorescence may be bracted to heavily bracted to almost foliaceous.) A scale was set counting four to many bracts as a character of *A. nemoralis* with the value of 0; three bracts with the value of 1, two bracts 2, and the presence of only one bract or none with the value of 3.

8. Although *Aster nemoralis* may have more than one head to an inflorescence, the single headed condition is very frequent and it was chosen to score it as characteristic, with the value of 0. Multiple heads almost invariably found

in *A. acuminatus* was given a score of 1. It is reasonable to suspect that this factor may be influenced by edaphic conditions. (*A.* × *Blakei* may have very great numbers of heads, to more than one hundred.)

9. Ligule color can be a fleeting thing, especially with herbarium specimens, where so much depends on collecting conditions and subsequent techniques of preservation. However, *Aster nemoralis* has colored ligules from bright, pure pink to lilac pink to rare crimson. The only specimen of *A. n.* f. *alba* Fern. examined was a seeming hybrid. The white to whitish ligules of *A. acuminatus* seldom display color even with aging and when there is a trace of pink, one may suspect introgression. Consequently, the presence of color was given the score of 0, a trace 1, and white 2. With perfect material more grades might be established.

10. The character "Zebra hairs" needs clarification (Figure 4). This is the name used for the hairs with reddish septations so abundant on the stem of *Aster acuminatus*. Under 30× magnification, the septa, which alone contain the red pigment glow like rubies giving a striated or zebra-like appearance to the hairs. Such hairs are entirely lacking on *A. nemoralis*. The occurrence of these hairs varies from abundant on *A. acuminatus* to sparse without the ruby coloring of the septa to completely absent on *A. nemoralis*. This character, while previously unused in describing *A. acuminatus*, seems useful for this hybrid index because its expression appears to be governed by additive factors.

An additional character could possibly be used in analyz-

Figure 4.

Enlarged (c.22×) photograph of stem-petiole area: *Aster acuminatus*: This specimen scored 26 on the hybrid index and would key to *A. acuminatus*. Note the dense curled and twisted hairs on the stem. This condition was rated abundant and scored the maximum of 2. Careful examination even in this black and white reproduction will reveal the striated condition that suggested the name "zebra hairs." These hairs are always found on *A. acuminatus* and are entirely absent on *A. nemoralis*.

ing this group as Torrey and Gray (1841) in describing the lower leaf surfaces of *Aster nemoralis* say "minutely dotted with resinous globules." A sampling survey of five hundred specimens ranging from *A. nemoralis* thru *A.* × *Blakei* to, and including, high scoring *A. acuminatus* shows this character with intense expression in *A. nemoralis*, somewhat lessening in *A.* × *Blakei* with a gradual decrease toward the end of the series approaching *A. acuminatus*. However, even specimens in this series with the highest scores showed, on close examination under 30× magnification some slight expression of this character. The presence of these globules which come to resemble glandular hairs when present in *A. acuminatus* bear little relationship to the presence of zebra hairs, both characters seemingly independently inherited in additive degrees.

While these resinous globules might make an additional character for the hybrid index however because of the practical difficulties of good quantitative measurement it would be hard to establish many categories. It seems in this series of specimens which all came from areas of overlapping range of the parental species the character of "resinous globules" has made complete introgression in some degree from one species into the other. An examination of the exposed lower leaf surfaces of the specimen in Figure 2, which was collected in Coos County, N. H., where no *A.* × *Blakei* has been recorded, failed to reveal any resinous dots. This should be pursued further in the examination of specimens not only beyond the range of recorded hybridity but where *A. nemoralis* itself does not occur.

During the next few years additional collections from different localities were assembled, several through the interest and courtesy of other collectors (Table 1). All specimens were scored by the hybrid index and each collection plotted on a diagram. The hybrid index ratings of selected characteristic populations is shown in Figure 5 with explanations. In addition all specimens of the three taxa *Aster nemoralis*, *A.* × *Blakei* and *A. acuminatus* in the herbaria of the New England Botanical Club and the Uni-

Table 1

STATION	LOCATION	TYPE OF HABITAT	COLLECTOR	DATE
Brier Island Road to North Light	Canada Nova Scotia Digby Co.	Very wet (drainage from higher elevation) rocky meadow on exposed headland	Hodgdon, A. R. & A. M. R. B. Pike R. I. Denbow	8/18/62
Peajack Road	Same as above	Abandoned road thru coniferous and mixed woods with wet sphagnous sections and open drier areas	"	8/19/62
Western Pt.	Same as above	Low central area with shrubby hummocks. Ledges on margins with coniferous woods and alders	"	8/20/62
East Wolf South West Cove	Canada New Brunswick Pennfield Parish Wolf Islands	Margin moist woods, south end barrier beach	Hodgdon, A. R. & A. M. R. B. Pike C. Saltonstall R. Burns	

STATION	LOCATION	TYPE OF HABITAT	COLLECTOR	DATE
Outer Wood Island	Canada New Brunswick Charlotte Co. Grand Manan	Narrow, wet, boggy meadow between white spruce, balsam fir woods and a cobble beach	Hodgdon, A. R. & R. B. Pike	8/22/61
Outer Wood Island	Same as above	Woods and small meadows adjoining original collection area, semi-shaded glades — depressions between ledges — with some higher and drier areas — juxtaposed habitats for both aster species and hybrids	Pike, R. B. J. B. Pike	8/21/63
Southern Head	Same as above	Peaty area above high cliffs on exposed headland — dominated by *Potentilla fruticosa*. Some alders, scattered conifers — asters in openings between	Pike, R. B. J. B. Pike	8/21/63

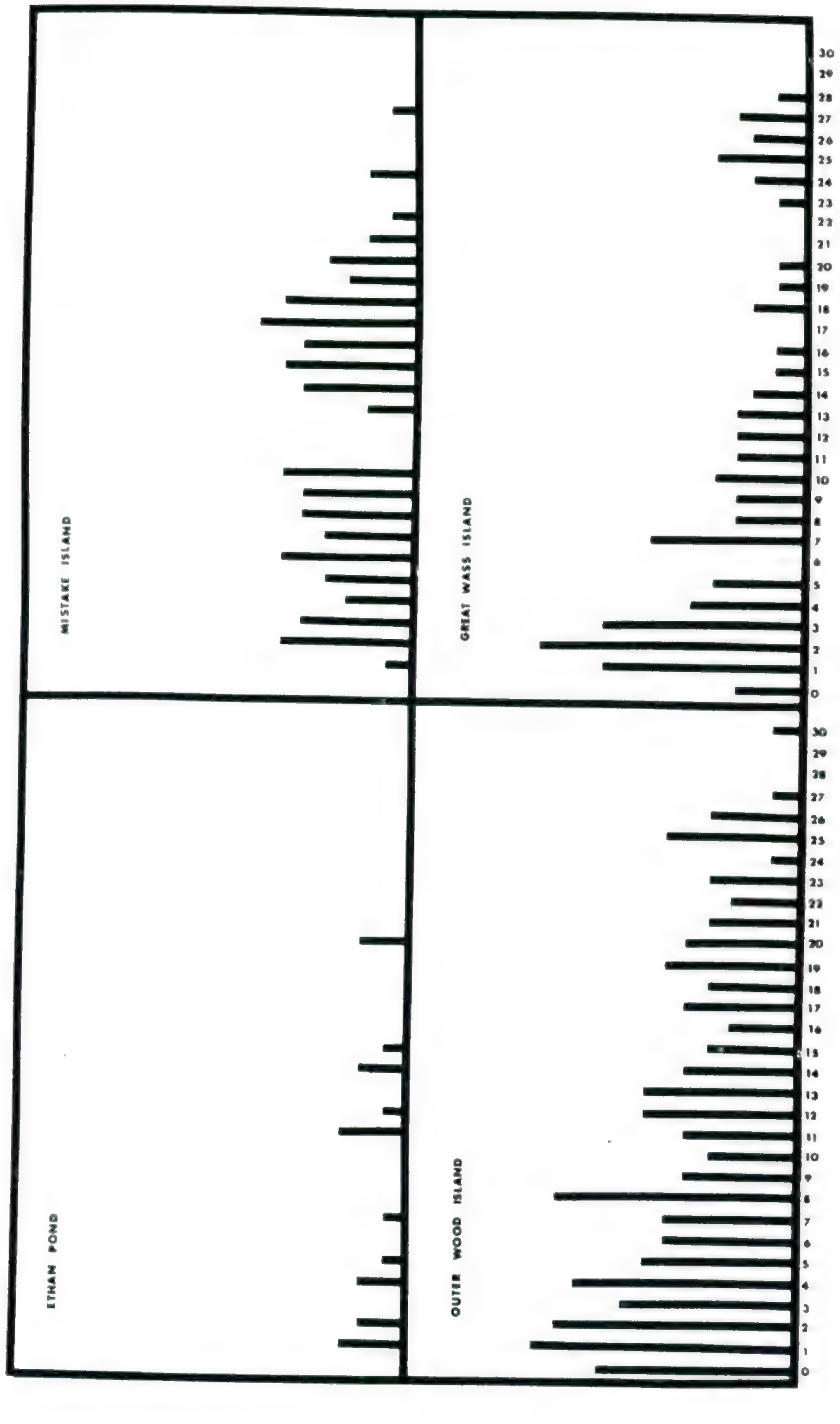
STATION	LOCATION	TYPE OF HABITAT	COLLECTOR	DATE
Mistake Island	Maine Washington Co. Jonesport	30 ft. swath kept open thru a growth of white spruce, balsam fir and alders. Moist spongy turf fully occupied with grasses, sedges and asters	Pike, R. B.	9/15/63
Mann Island	Maine Washington Co. Jonesport	Almost bare granite island with bog in central basin — a few shrubs & conifers on margins and in larger crevices of ledges	Pike, R. B.	9/15/63
Great Wass Island	Maine Washington Co. Beals	Point sparsely wooded with conifers, small marshy area between alders and beach — with suitable habitats for both species and hybrids	Hodgdon, A. R. & R. B. Pike	8/23/63
Near National Park Cabin	Maine Knox Co. Isle au Haut	Steep rocky banks of stream in spruce arbor-vitae forest	Hodgdon, A. R. & David Wise	9/12/68

STATION	LOCATION	TYPE OF HABITAT	COLLECTOR	DATE
Back Narrows	Maine Lincoln Co. Boothbay	Bog open-wet-clumps shrubs and low forest *Abies balsamea, Larix laricina, Picea rubens, Aster nemoralis* in wet areas, *A. acuminatus* in wooded areas, *A.* × *Blakei* in intermediate spots	Hodgdon, A. R.	8/31/62
White Lake	New Hampshire Carroll Co.	Steep sandy talus bank on shore of lake with mixed woods above and in back	Straus, C. M.	9/7/64
Chocorua Lake	Same as above	Sandy peaty area on shore of lake	Steele, F. L.	8/25/62
Ossipee Lake	New Hampshire Carroll Co. Ossipee	Lake margin with sandy beach grading into peaty area and backed by swampy woods	Hodgdon, A. R.	9/17/62
Ethan Pond	New Hampshire Grafton Co. Bethlehem	Boggy margin of lake	Steele, F. L.	8/13/62

versity of New Hampshire were scored thus giving a broad spectrum of specimens over much of the range. All hybrid index scores of 972 specimens were combined in a summation diagram (Figure 6).

A further analytical technique that often proves useful in studies of natural hybridity is the "scatter diagram" (Figure 7). It demonstrates hybridity within a population but only for two characters. However by adding supplementary symbols for other characters, linkage patterns may appear. After making scatter diagrams for many pairs of characters and for most populations studied, it was apparent that the hybrid index shows the hybrid relationship more completely.

An interesting skew toward *Aster nemoralis* (Figure 5, Outer Wood and Great Wass Island populations) becomes striking with consolidation of the scores (Figure 6). The five values at either end are typical of the parental species yet show expected intraspecific variation. Plants scoring from 8 to 19 would fit *A. Blakei* according to the description in the 8th Edition of Gray's Manual. Plants with scores from 5 to 7 and from 20 to 25 show varying degrees of introgression toward the parental species and present difficulties of classification which become obvious in examining collections in herbaria. These categories have made the classification of these asters impossible without recognizing their hybridity. The skew of the graph toward *A. nemoralis* not only represents a greater number of individuals but it should be emphasized that these are usually biologically successful as becomes evident upon an examination of the plants involved. A comparable survey of the plant material comprising the scores introgressing toward *A. acuminatus* shows not only a distinct reduction in numbers but a series of relatively poor and often strange-looking plants. Possibly the backcross to *A. acuminatus* produces biologically less successful progeny than the backcross to *A. nemoralis*. It may be that in this area the sterile forms originate that are described as *A. a.* f. *discoideus* by Kutze and *A. a.* f. *virescens*, *Victorin* and *Rous-*


MISTAKE ISLAND
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ETHAN POND
OUTER WOOD ISLAND
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seau. These asters with pom-pom heads of empty chaff have been an enigma as well as a fascination to collectors. The latter is attested by the remarkable number which occur in herbaria. As the possibility of pathological origin exists, these forms were not considered in this study.

It is probably significant to note that although *Aster Blakei* has been considered as a variety of *A. nemoralis* no botanist has suggested that it might be a variety of *A. acuminatus*. This reflects the position of *A.* × *Blakei* as demonstrated in the graph of Figure 6 which shows it to have more characters of *A. nemoralis* than *A. acuminatus*. This tendency is shown in looking through folders of specimens in herbaria as one often finds *A. Blakei* classified wrongly as *A. nemoralis*, but only very rarely does one find an *A.* × *Blakei* in a folder of *A. acuminatus*.

Figure 5.

All four of the populations plotted on the above diagrams show introgression with a wide range of scores derived from the hybrid index. Both 1960 and 1963 collections totaling 158 specimens were used to construct the Outer Wood Island table since the areas of collection were adjoining and more or less continuous and only weather prevented their being collected at one time. This was the first area showing full range from *Aster nemoralis* to *A. acuminatus* with a strong middle range of *A.* × *Blakei*. No record exists of any previous observation of such a population.

The table for the Great Wass Island population is equally striking, although composed of only eighty-nine individuals. Mistake Island is a third maritime station with comparable ecological conditions and its population sample also of 89 specimens displays a practically complete range of hybrids as well as good examples of the parent species.

Ethan Pond in the White Mts. of New Hampshire at an elevation of 2,900 ft. can be regarded as a montane habitat. The population sample of 17 specimens collected here by Frederic Steele, while not as large as shown in the other tables, shows a range of specimens from good *Aster nemoralis* to *A.* × *Blakei* and a few specimens with some tendency toward *A. acuminatus*. The population at this station can be regarded as nearly typical of previous collecting sites with few if any specimens showing obvious characters of *A. acuminatus*, the absence of suitable habitat not favoring this sector of the population.

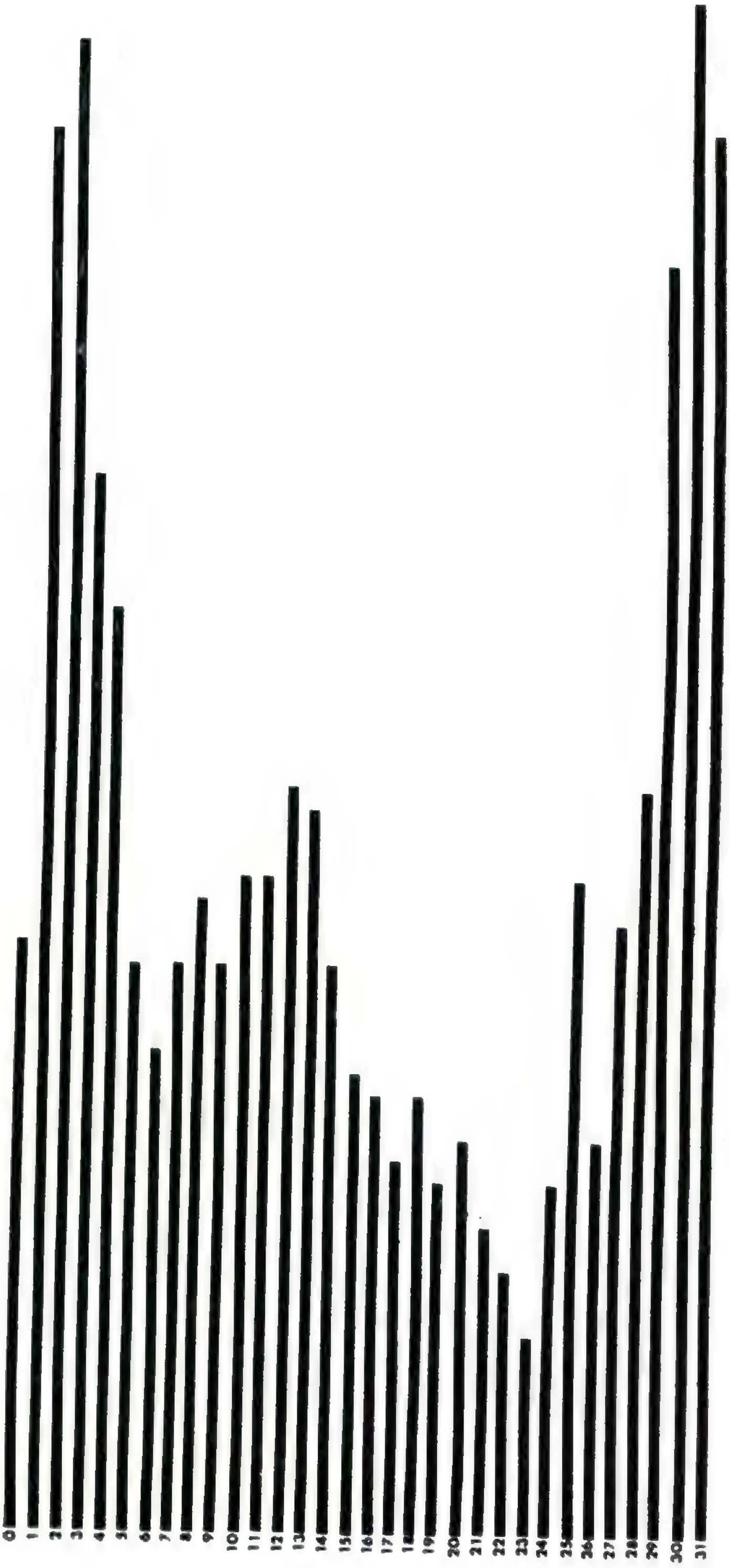

Figure 6.

Hybrid index ratings of 972 specimens of *Aster nemoralis*, *A.* × *Blakei* and *A. acuminatus* in the herbaria of the University of New Hampshire and of the New England Botanical Club at Harvard and the collections listed in Table 1. *A. nemoralis* at the left (0-4), *A.* × *Blakei* in the center (8-19), *A. acuminatus* at the right (25-31). The remaining numbers are the intergrading intermediates.

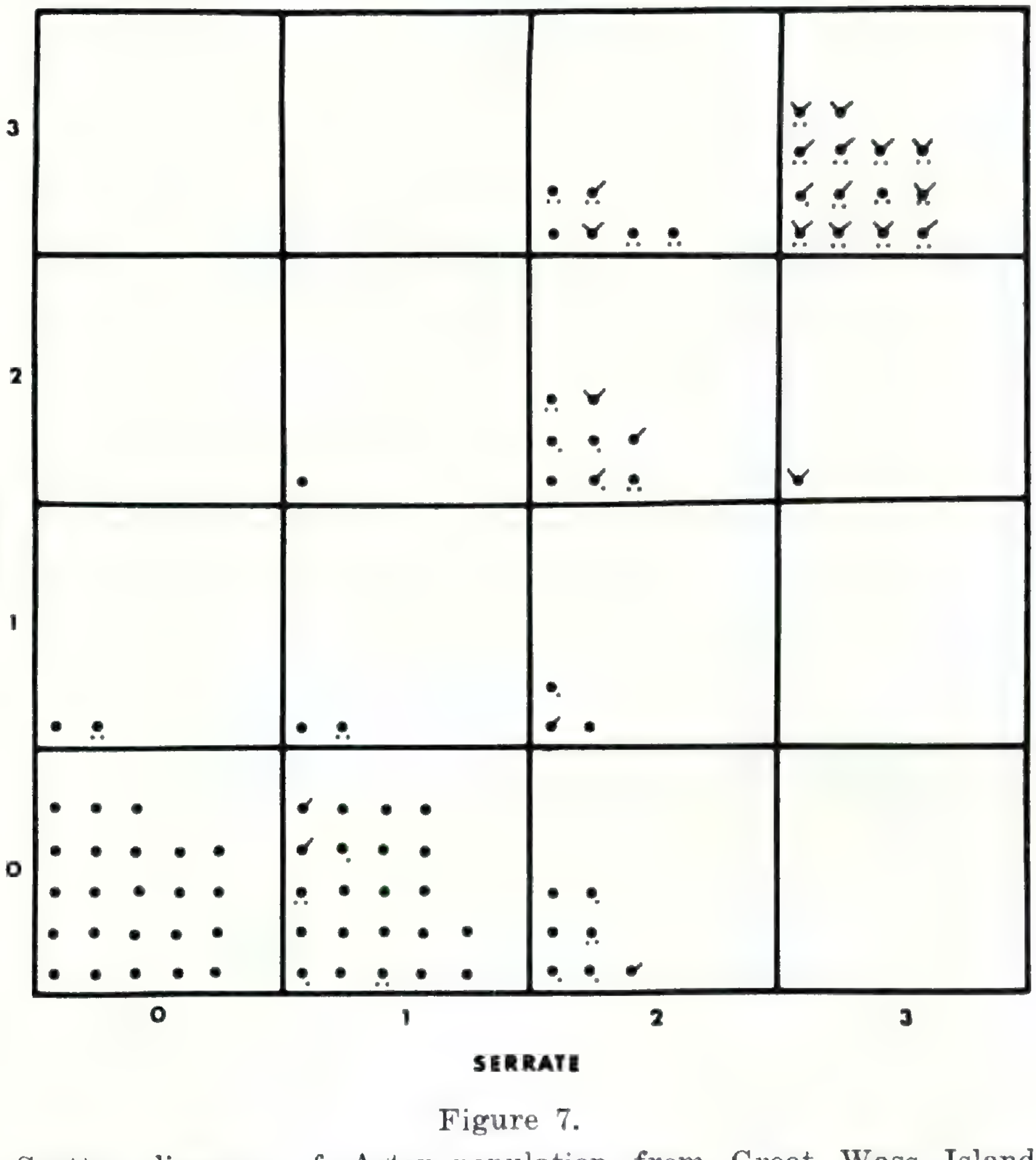

Figure 7.

Scatter diagram of Aster population from Great Wass Island plotted for two leaf characters, each of which had been assigned four values, from zero to three. Revolute leaves, with no serrations characteristic of *Aster nemoralis* (assigned value 0) are plotted in the lower left corner. Flat leaves with large serrations characteristic of *A. acuminatus* (assigned value 3) are placed in the upper right corner. The remaining plants are placed in squares according to their scoring for these two characters. Thus, this diagram shows hybridity of the intervening plants only for these two leaf characters.

The supplementary symbols indicate the distribution of two other characters, in this case median internode length and bracts on peduncle. The rabbits ears indicate increasing internode lengths and the small dots decreasing numbers of bracts on the peduncle. (See hybrid index for scores.) Similar diagrams were made for the thirteen population collections under analysis, but while they are valuable for studying pairs of characters and possible linkages they do not give a comprehensive demonstration of total introgression that is afforded by Fig. 6 which is based on all ten characters.

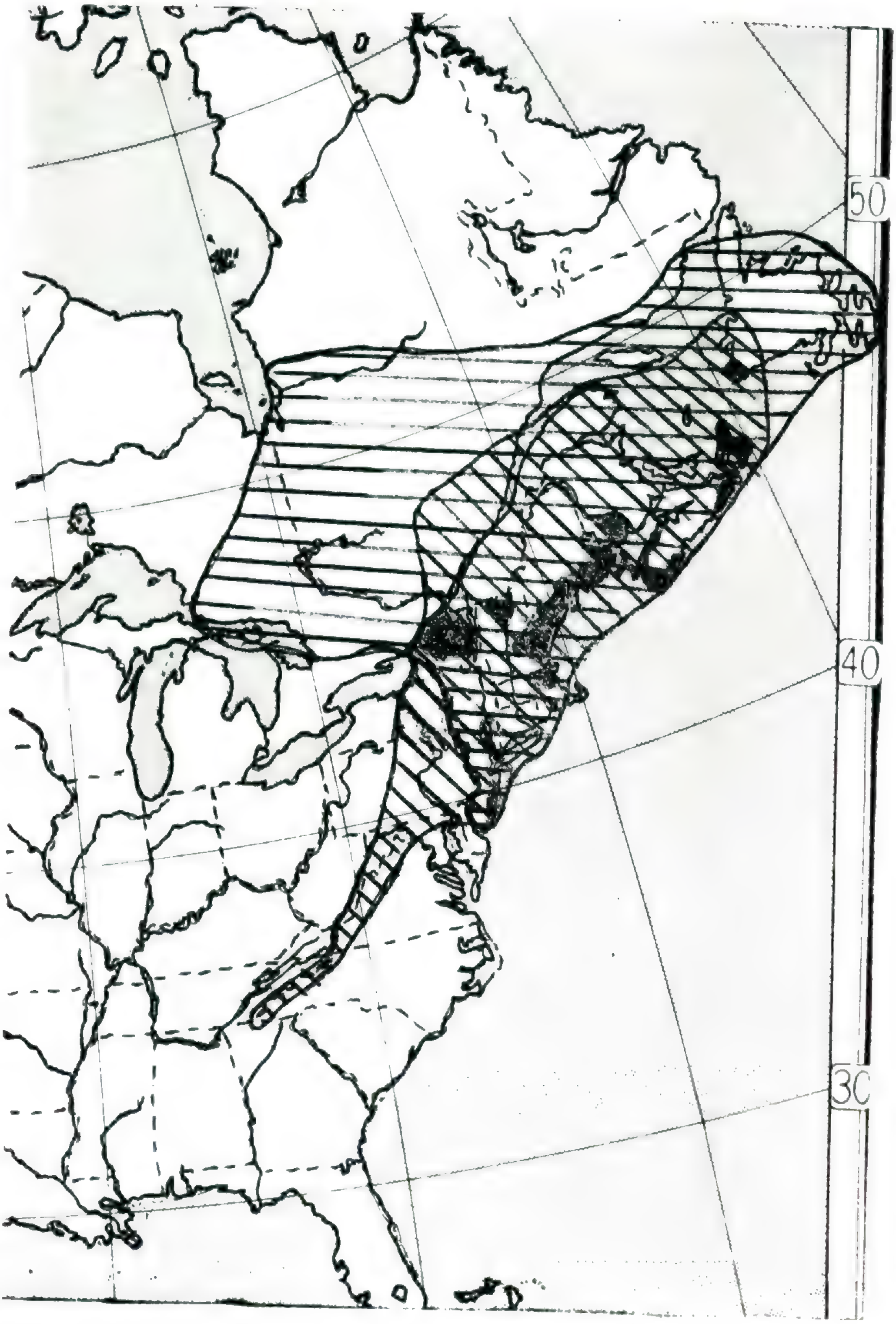

Figure 8, Map.

The geographical range of *Aster nemoralis* is indicated by horizontal lines and *A. acuminatus* by diagonal lines. Shading indicates areas from which collections of *A.* × *Blakei* have been recorded. Note that there are no records of the hybrid outside the cross-hatched section.

While both *Aster nemoralis* and *A. acuminatus* are northern and eastern asters, their ranges (Map, Figure 8) are not quite the same. *A. nemoralis* is found in most of Newfoundland, along the north shore of the Gulf of St. Lawrence including Anticosti Island, in the basins of the Rupert and East Main rivers that run into James Bay, the southern tip of Hudson's Bay, to the junction of Lakes Huron and Michigan, in northern New York state south along the coast to Cape May, New Jersey, in addition to the New England states and the Maritime Provinces.

The range of *Aster acuminatus* is northern yet does not extend as far north as *A. nemoralis*. Jennings (1953) says of it: "This northern aster which requires a cooler climate, evidently has migrated up into the mountains and northward since the melting away of the glacial ages." It barely extends into Newfoundland and along the St. Lawrence from the Saguenay River to Ottawa, north to Lac St. Jean, then south along the Appalachians to the junction of Tennessee, North Carolina and Georgia, much of New Jersey and New York as well as New England and the Maritime Provinces.

It is only within the overlapping ranges of these two species that *Aster* × *Blakei* has been recorded. The areas of collection have been primarily, but not exclusively, maritime or montane and are notably discontinuous. There is the strong suggestion that the conditions allowing the formation of the hybrid, *A. Blakei*, have occurred at numerous times and places and that either one or both parents have not survived subsequent ecological changes. Apparently, the only areas at the present time with the proper coincidence of habitat and meteorological conditions are the few reported stations on the Maine Coast and Bay of Fundy.

Fernald's statement (1950) regarding *Aster* × *Blakei*, "Sometimes called a hybrid of nos. 59 and 61, rarely associated with either or both, very fertile and uniform and unknown from much of their coincident areas" needs to be examined critically. Observation in the field as well as

in herbaria shows *A.* × *Blakei* to be almost invariably associated with the parent *A. nemoralis* and careful search will often disclose evidence of *A. acuminatus* not too far away. In twelve stations observed in this study both parents and the hybrid have been found growing in close proximity. Fernald's assumption of fertility may not have had much scientific basis. What may appear to be separate plants in an area may in reality be one or more clonal groups connected by underground rhizomes*. Collections many years apart indicate these clonal groups are long lived and persistent. These same facts explain his comments on the uniformity of the plants.

As for being unknown from much of the coincident area of the parents the important fact is that it occurs only in this coincidental area. When the specialized habitats of the parents are considered the points of contact where hybridization can take place are indeed limited which would impose a discontinuity of distribution.

The transition from wet sphagnum bogs to coniferous woodland is of common occurrence in northern New England and the Maritime Provinces. The transition areas are usually dominated by ericaceous shrubs and tall sedges and grasses, then rather abruptly grade into taller thickets of *Myrica gale, Nemopanthus, Ilex verticillata, Salix* spp. and finally alders before the coniferous species dominate on higher and drier areas. The habitat of *Aster nemoralis* is the open bog, often the wettest spots where there is little

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*The distinction between stolon and rhizome is confusing at best. Fernald (1950) used both terms in describing *Aster nemoralis*. Whether he meant them synonymously is not quite clear. In his glossary he defines rhizome as, "Any prostrate or subterranean stem, usually rooting at the nodes and becoming upcurved at the apex." Stolon is defined as, "A runner or any basal branch that is inclined to root." Gray (1887) says a stolon is "a branch from above ground which reclines or becomes prostrate and strikes root . . .", while "a rhizome (Rhizoma) . . . is merely a creeping stem or branch growing beneath the surface of the soil, or partly covered by it." The latter definition from Gray is the sense in which the term rhizome will be used in this paper.

Figure 9.

Specimens scoring 0 to 2 on the hybrid index from 1960 population collection of sixty-nine individuals, from Outer Wood Island, Grand Manan. All are excellent examples of *Aster nemoralis* showing expected intraspecific variation.

Figure 10.

Specimens scoring 9, 10, 11 and 12 on the hybrid index showing characters intermediate between the plants shown in Figures 9 and 11. They key as *Aster* × *Blakei*.

Figure 11.

Asters scoring 19 on the hybrid index show strong influence of both parents and are properly classed as *Aster* × *Blakei*.

Figure 12.

Plants scoring 25 on the hybrid index fall within the range of *Aster acuminatus* and key to this species in Gray's Manual of Botany, 8th edition. These specimens are from the same original population as those shown in Figures 9, 10 and 11 and are the extremes on the *A. acuminatus* end of the scale.

or no shade competition except from low thin sedges, while *A.* × *Blakei* being taller and more shade tolerant and vigorous endures the competition of subshrubs, grasses and sedges at the first part of the transition zone. Moreover segregates contiguous to *A. nemoralis* physically seemingly approach it also in tolerance of habitat wetness and can thus compete in wet boggy areas with taller vegetation of possibly up to two to three feet. Where the abrupt change to taller shrubs occurs with their dense growth, suitable habitats cease. Not until the forest margin do suitable habitats for *A. acuminatus* appear. Thus the ecological niches of *A. nemoralis* and *A. acuminatus* are almost invariably separated. Where *A. Blakei* occurs, it must mean that at some time the two areas adjoined one another and hybridization occurred. The survival of *A. Blakei* can be attributed to its moderate tolerance of wetness and its superior stature and vigor. Subsequent changes allowing the penetration and development of tall shrubs would eliminate *A. acuminatus* leaving the hybrid with its superior capacity for spreading by rhizome extension on the bog margins with opportunity to backcross to *A. nemoralis*. Without question, this is the explanation of the existence of populations such as those at Ethan Pond and other inland stations where *A.* × *Blakei* is found associated only with the *A. nemoralis* parent.

The pattern of transition from wet sphagnum bog to coniferous forest breaks down on the coast of eastern Maine and the Bay of Fundy. Here in the saturated atmosphere of that foggy climate, the sphagnum of the bogs may invade and even destroy the coniferous forest, frequently with little or no transition zone of sedges and shrubs. Here the ecological requirements of both parental species coincide allowing hybridization and continued survival of parents and progeny.

Both *Aster acuminatus* and *A. nemoralis* have become adapted to highly specialized habitats; habitats, moreover, that must have long existed in the mesic forests and bogs of the east and northeast, fluctuating with glacial advance

and retreat. Only rarely, would such contrasting habitats coincide and the conditions of coincidence must have borne close resemblance to the cold maritime sites of Outer Wood Island, Great Wass Island, Mistake Island and to the montane locations of Ethan Pond and Chocorua Lake. The ecological similarity of montane sites and sea level bogs is noteworthy and is especially high-lighted by an as yet unpublished study by Teeri, et al, on Campobello Island, New Brunswick. Within the overlapping ranges of *A. acuminatus* and *A. nemoralis*, such ecologically exacting sites must have repeatedly occurred during Pleistocene advance and retreat. With ecological barriers thus removed, genetic compatibility becomes evident with the appearance of the *Aster* × *Blakei*.

With vigorous vegetative propagation by far ranging rhizomes inherited from both parents and adaptation to a hybrid habitat, *Aster* × *Blakei* was in a position to survive without direct competition with either parent. With at least some genetic compatibility allowing backcrossing, *A.* × *Blakei* was in a position to maintain itself once the initial interspecific crossing was accomplished. With changing conditions, the specialized environments of one or both parent species could be wiped out, leaving *A.* × *Blakei* alone in its less vulnerable habitat, or with one or the other of its parents. The fact that it has been found with one parent more often than the other can be explained by postulating either greater genetic compatibility in one direction than the other or a greater availability of suitable environment in one direction than the other or a combination of both factors.

ASTER × BLAKEI

Representative Specimens

The following specimens have been selected from all over the recorded range of *Aster* × *Blakei*. They have been examined and verified as meeting the description and falling within the hybrid index values of *A.* × *Blakei*.

CANADA: NEWFOUNDLAND: Port aux Basques, *Fernald, Long & Dunbar* 27141 (GH).

NOVA SCOTIA: CAPE BRETON: VICTORIA CO., St. Paul Island, *Perry & Roscoe* 397 (GH); North Sydney. *Bissell & Linder* 22812 (GH); GUYSBOROUGH CO., West Cook's Cove, *Perry & Wetmore, Hicks & Pringle* 10017 (GH); Canso, *Fowler* 8801 (GH); HALIFAX CO., Halifax, *Howe & Lang* 1506 (GH); ANNAPOLIS CO., Liverpool Head Lake, *Fernald & Long* 22462 (GH); QUEENS CO., Broad River, *Fernald & Bissell* 22811 (GH); SHELBURNE CO., Shelburne, *Fernald & Long* 24660 (GH); YARMOUTH CO., *Fernald, Long & Linder* 22813 (GH); DIGBY CO., Haverlock, *Fernald & Long* 24661 (GH); Brier Island, Western Point, Aug. 19, 1962, *Hodgdon, Hodgdon, Pike & Denbow* (NHA).

NEW BRUNSWICK: CHARLOTTE CO., Wolf Islands, East Wolf, Southwest Cove, Sept. 19, 1964, *Burns, Hodgdon, Hodgdon, Pike & Saltonstall* (NHA). Grand Manan, Outer Wood Island, Aug. 21, 1963, *Pike & Pike* (NHA).

UNITED STATES: MAINE: FRANKLIN CO., New Sharon, Aug. 10, 1902, *Knowlton* (NHA); OXFORD CO., Adamstown, *Pease* 26458 (NEBC); Waterford, Bog Pond, Aug. 16, 1883, *J. Blake* (MAINE); WASHINGTON CO., Marshfield, *Knowlton* s.n. (NEBC); Roque Bluffs, July 27, 1913, *Knowlton* (NHA); HANCOCK CO., Mt. Desert Island, Great Pond, Sept. 31, 1895, *Faxon* (GH); Broad Cove, Sept. 13, 1894, *Rand* (NEBC); KNOX CO., Isle au Haut, Sept. 12, 1968, *Hodgdon* (NHA); LINCOLN CO., Boothbay, Ocean Point, *Fassett* 2956 (NEBC); Southport, July 31, 1894, *Fernald* (NEBC); KENNEBEC CO., Monmouth, Sept. 25, 1896, *Fernald* (NEBC); SAGADAHOC CO., Topsham, *Bean* s.n. (NEBC); ANDROSCOGGIN CO., South Poland, 1895, *Kate Furbish* (NEBC); CUMBERLAND CO., Baldwin, *Fernald, Long & Norton* 14478 (NEBC); Otisfield, Moore Pond, Aug. 1958, *J. Blake* Bowdoin Collection (NHA); YORK CO., Limington, *Fernald, Long & Norton* 14747 (NEBC); Wells, Aug. 1849. *J. Blake* Bowdoin Collection (NHA).

NEW HAMPSHIRE: CARROLL CO., Wolfeboro, Carrying Place, Aug. 27, 1909, *Sargent* (NHA); Tamworth, Chocorua Lake, Sept. 21, 1865, *J. Blake* Bowdoin Collection (NHA); Ossipee, *Pease* 30386 (NEBC); GRAFTON CO., Bethlehem, Ethan's Pond, *C. & E. Faxon* 82777 (GH); Livermore, Aug. 15, 1948, *M. Gale* (NHA); Enfield, *Kennedy* 8390 (NEBC).

STRAFFORD CO., Madbury, *Hodgdon, Hehre, Teeri & Bruns* 14576 (NHA); Somersworth, *Hodgdon & Giddings* 4944 (NHA); Strafford, *Hodgdon* 2918 (NHA);

BELKNAP CO., Gilmanton, Shellcamp Pond, Aug. 28, 1876, *J. Blake* (MAINE);
MERRIMAC CO., Hooksett, Aug. 24, 1925, *Batchelder* (NHA);
ROCKINGHAM CO., Northwood, *Pease* 31793 (NEBC); Deerfield, *Pease* 31784 (NEBC);
HILLSBORO CO., Hancock, Sept. 7, 1963, *Patricia Stocking* (NHA); Peterboro, Sept. 2, 1901, *Williams* (NEBC);
CHESHIRE CO., Rindge, Sept. 14, 1913, *Forbes* (NEBC); Jaffrey, *Robinson* 82898 (GH).
VERMONT: ESSEX CO., Brunswick, *Pease* 29324 (NEBC);
LAMOILLE CO., Johnson, Belden Pond, Sept. 1, 1894, *Grout* (GH).
MASSACHUSETTS: ESSEX CO., Gloucester, Aug. 30, 1881, *Swan* (NEBC); Hamilton, *Hunnewell* 4630 (NEBC);
MIDDLESEX CO., Chelmsford, Sept. 20, 1902, *Knowlton* (NEBC); Bedford, Oct. 1896, *Jenks* (GH);
PLYMOUTH CO., Wareham, *S. F. Blake* 10751 (GH); East Wareham, *Griscom* 12767 (NEBC);
WORCESTER CO., Uxbridge, *A. Gray* 3282 (GH); Hubbardston, Sept. 9, 1940, *Weatherby & Rollins* (NHA).
RHODE ISLAND: WASHINGTON CO., South Kingston, *Griscom* 24023 (NEBC); Hopkinton, *Lownes* 466 (GH);
KENT CO., East Greenwich, *Congdon* 4697 (MAINE).
NEW YORK: HERKIMER CO., Big Moose Station, July 12, 1899, *Peck* (GH); Five Ponds, Aug. s.n., *Chas. H. Peck* (N.Y.S.)
HAMILTON CO., Lime Kiln Lake, *Wiegand* 16762 (GH);
ST. LAWRENCE CO., Clifton, *Wright* 13042 (GH).
NEW JERSEY: OCEAN CO., Egg Harbor, Sept. 19, 1897, *Pollard* (GH); Lakewood, *Hunnewell* 6335 (GH).

Acknowledgments

The collection and preparation of botanical material, the searching in herbaria and the borrowing of specimens involve the help of many people and institutions. The courtesies of the curatorial staffs of the following Herbaria have been sincerely appreciated: New England Botanical Club; Gray Herbarium; University of Maine; Pringle Herbarium; Philadelphia Academy of Sciences; University of Pennsylvania; New York State Museum and the private herbarium of Col. Wm. Countryman at Norwich University.

The Bowdoin collection now on ten year loan to the University of New Hampshire Herbarium has been remarkably

valuable as it contains specimens collected by the Rev. J. Blake who over 100 years ago recognized the position of the aster later named for him.

The graphic diagrams in Figs. 1, 2 & 3 were constructed by Norman Reynolds of the Botany Department, and the photographs of specimens were made by staff of the Photographic Department both of the University of New Hampshire.

Constant associate and mentor in this study Albion R. Hodgdon, Curator of the Herbarium of the University of New Hampshire.

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CHROMOSOME NUMBERS OF ASTER BLAKEI AND A. NEMORALIS[1]

L. MICHAEL HILL and O. M. ROGERS

Pike (1970) has presented morphological and geographical evidence for the possible hybrid origin of *Aster Blakei* (Porter) House from *A. acuminatus* Michx. and *A. nemoralis* Ait. Investigations of the chemistry and cytology of controlled interspecific crosses of this complex have been continued in our laboratory. One of the first results of this study has been the determination of the chromosome numbers of two of these taxa which have not been published to date.

Root tips of all plants studied were pretreated with 8-oxyquinoline and stained and squashed according to a schedule used by Huziwara (1957). The slide and cover slip were separated using a method described by Celarier (1956). Both slide and cover slip were run through an acetic acid — ethyl alcohol series (1:1, 1:3, 1:9) and two changes of absolute ethyl alcohol before being recombined in Diaphane.

The chromosome numbers are listed in Table I. The number obtained for *A. acuminatus* is in agreement with that of Nelson (1966). Voucher specimens of the plants from which these numbers were obtained are housed in the University of New Hampshire Herbarium.

Table I. Chromosome numbers of *Aster* spp.

Aster acuminatus	$2n = 18$
Aster Blakei	$2n = 18$
Aster nemoralis	$2n = 18$

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ON THE TAXONOMY AND DISTRIBUTION OF VACCINIUM ULIGINOSUM

STEVEN B. YOUNG

The tundra bilberry, *Vaccinium uliginosum* L. is a characteristic shrub of tundra and muskeg in boreal, arctic and alpine regions. The species has a circumpolar range (Fig. 1) which extends southward into the temperate zone in coastal regions and mountainous areas.

Various morphological and cytological features of the *V. uliginosum* complex have been discussed by a number of authors, including Fernald (1923), Petersen (1933), Hagerup (1933), Malte (1934), Hara (1953), Young (1965, unpub.), Löve and Löve (1966), and D. Löve and Boscaiu (1966). Most of these treatments refer to certain circumscribed geographical areas, and the methods used to distinguish races within these areas have often proved to be unworkable when applied on a broader scale. There is a great deal of morphological variation within the complex, but much of this variation is quantitative rather than qualitative: few clearcut morphological discontinuities are to be found. An additional complication results from the wide range of ecological tolerance found in some populations of *V. uliginosum*. These populations show much variation in leaf size, growth habit, phenology, and other characters. Much of this variation seems to be ecologically induced. Lack of information on the breeding systems and on the genetic structure of the races of *V. uliginosum* further complicates the situation.

In spite of these difficulties, there are a number of clearcut patterns of morphological variation which can be discerned when the *V. uliginosum* complex is treated on a circumpolar, holarctic scale. These patterns are correlated with distributional and cytological data. They allow the delineation of a series of distinct, wide ranging races within the *V. uliginosum* complex. Most of these races intergrade more or less freely in zones of range overlap, even though

they may differ cytologically. Therefore, the races are here treated as subspecies, at least one of which can be further subdivided into two varieties.

CYTOLOGY

At least three levels of a euploid sequence based on $n=12$ have been found in *V. uliginosum*. The collection locations of specimens from which chromosome counts have been made are shown in Fig. 1.

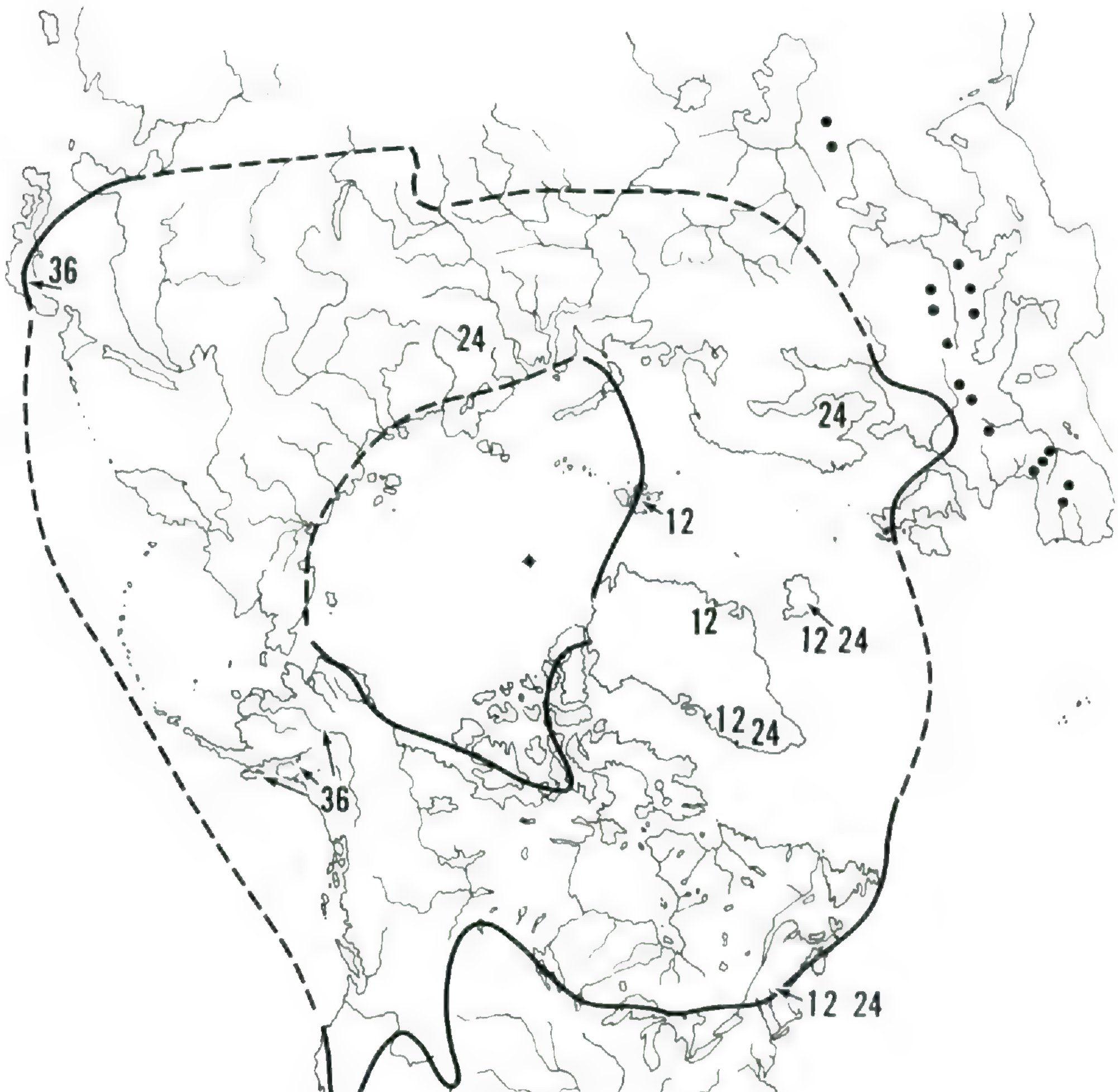

Fig. 1. Outline of the range of *Vaccinium uliginosum* s. lat. Dots indicate isolated alpine stations in Europe. The numbers indicate documented chromosome counts and the locations at which the specimens were collected.

Documented chromosome counts of $n=12$ (diploid) have been obtained from Greenland (Hagerup, 1933, Jorgensen, et al, 1958), Spitzbergen (Flovik, 1940), Iceland (Löve, 1950, 1954), and Mount Washington, New Hampshire (Löve and Löve, 1966).

Counts of $n=24$ have been made from Greenland (Hagerup, 1933, Jorgensen et al, 1958), Iceland (Löve, 1954, Löve and Löve, 1956), Sweden (Hedberg and Hedberg, 1964), and arctic Russia (Sokolovskaya and Strelkova, 1960).

Counts of $n=36$ are reported from alpine areas in Honshu, Japan (Hara, 1953), and from a number of stations in central and southern Alaska (Young, 1965, unpub.).

In the course of an earlier study on *V. uliginosum* in Alaska (Young, 1965, unpub.), I made over 100 slides of meiotic material of *V. uliginosum* from many stations in Alaska. I was able to obtain counts from 10 stations which I was reasonably satisfied represented exactly $n=36$. However, the majority of the counts showed anomalous numbers. In many cases it was clear that there were more than 24 but less than 36 chromosomes, while in a few cases the number appeared to exceed 36. One slide made from material from an alpine station on Kodiak Island seemed to show $n=18$, while material from nearby stations was often clearly $n=36$.

Chromosomes of Alaskan material of *V. uliginosum* are small and "sticky." Stages of meiosis suitable for counting are difficult to find, and cytoplasmic staining is often a problem. Therefore, it is difficult to get a perfectly accurate count, particularly when the chromosomes are numerous. However, there can be no doubt that many Alaskan specimens of *V. uliginosum* have a chromosome complement that is anomalous in terms of the normal sequence based on $n=12$. A similar situation has been described by Lewis (1970) in populations of *Claytonia virginica* L. in Texas. It was found that chromosome numbers in these populations varied between individuals within populations, between various organs of individual plants, and, in terms of average numbers, throughout the population as a whole over

a period of time. The latter phenomenon apparently was correlated with climatic stress (drought in that case). It seems likely that there is a similar situation of "Chromosomal Drift" in many Alaskan populations of *V. uliginosum*. The significance of this situation with respect to fertility and breeding systems is not clear. It seems likely that the great amount of morphological variability observed in central Alaskan populations of *V. uliginosum* is correlated with a complex genetic structure of the populations, and that variations in chromosome numbers are an aspect of this complexity. It is unfortunate that the relatively long life cycle of *V. uliginosum* militates against using the species in hybridization studies.

MORPHOLOGY AND TAXONOMIC CRITERIA

In approaching the taxonomy of *V. uliginosum* on a holarctic scale, leaf pubescence and growth habit of the plant are the most useful morphological characters. These characters also show good correlations with distributional data, and there are many areas in which all populations of *V. uliginosum* seem to be quite uniform in terms of these characters. Areas in which there is more variation in leaf pubescence and growth habit are apparently zones of contact and intergradation between two or more races. In the case of growth habit, there is often considerable variation in geographically complex areas such as central Alaska; this variation must, to some extent, be ecologically induced.

A third character of major significance is the presence or absence of stomates on the upper surface of the leaves. This character is easily determined on herbarium specimens, using the plastic imprint technique described by Sinclair and Dunn (1961). The presence or absence of stomata on the upper surface of the leaves is the only character I have found that allows a race of *V. uliginosum* to be distinguished in all cases.

Several of the characters which earlier workers have considered to be useful in distinguishing races of *V. uliginosum* seem to be of little value when applied on a holarctic

scale. Variation in the length and angle of divergence of anther horns has been considered to be significant by a number of workers. Short, ascending anther horns were thought by Hagerup (1933) to be useful in distinguishing tetraploid plants in Greenland from their long-horned diploid counterparts. Short, even obsolete anther horns occur commonly in most populations of *V. uliginosum* from the more temperate parts of the range, but in no case does their occurrence seem to be universal throughout a population.

Size, shape, and color of the corolla, mean number of carpels, length of pedicels, and the number of flowers per inflorescence all vary somewhat between the major races of *V. uliginosum*. In no case is the variation in any one of these characters great enough to use it as a diagnostic taxonomic character.

D. Löve and Boscaiu (1966) indicate that *V. gaultherioides* (here treated as *V. uliginosum* ssp. *gaultherioides*) can be distinguished from *V. uliginosum* s. str. on the basis that *V. gaultherioides* lacks small, stalked glands along the margin of the base of the leaf. In all of the several hundred specimens of *V. uliginosum* s. lat. that I examined, I found none in which these glands did not occur on at least some of the leaves. The glands are most noticeable on young leaves and tend to wither on older leaves.

Narrow-leaved individuals occur in most races of *V. uliginosum*, but they are most commonly found in populations in northwestern North America. Individuals with narrow leaves have sometimes been given taxonomic status (e.g. *V. salicinum* Cham.). However, these individuals seem to occur randomly in otherwise normal populations, and they are of little or no taxonomic significance.

Fruit characters are of little use in the taxonomy of *V. uliginosum*, partly because the shape and size of the fruits are difficult to determine from pressed specimens. Fruits of ssp. *pedris* are quite variable in shape (c.f. Shacklette, 1962), while those of other races are normally spherical. There is apparently considerable variation in the sugar con-

tent and palatability of the fruits between races (Harshberger, 1928, Hagerup, 1933).

Porsild (1951) claimed that there are two races of *V. uliginosum* in northwestern Canada. These races are supposedly distinguishable on the basis that one has fruits with persistent, "captitate" styles, while the other has deciduous "continuous" styles. The styles of most specimens of *V. uliginosum* exude a drop of a resinous substance at the tip at about the time of anthesis, perhaps as a pollen trapping mechanism. This exudate hardens into an acellular globule at the end of the style at the same time that the style is withering and diminishing in diameter. The result is a "capitate" style, which occurs on all *V. uliginosum* specimens with mature fruit that I have studied. The style is usually jointed at the base and easily broken off when the fruits are mature. I have seen no specimens in which the presence or absence of the style on the fruit can be considered to have taxonomic significance.

CORRELATION BETWEEN MORPHOLOGICAL AND CYTOLOGICAL DATA

A major problem in the taxonomy of the *V. uliginosum* complex has involved attempts to correlate morphological characters with cytological data. In East Greenland and northern Europe there are fairly clear cut morphological and habitat-preference separations between the two common races of the complex. There is sufficient data to indicate that procumbent, small-leaved populations growing in dry situations in arctic areas are diploid, while tall, large-leaved hydrophytes from more temperate regions are tetraploid (Hagerup, 1933, Löve and Löve 1966). However, in other parts of the world, there is neither the clear cut morphological discontinuity between the races of *V. uliginosum* that occurs in Atlantic regions, nor is there a sizable body of chromosome data on which to attempt to base correlations. There is also evidence, discussed above, that there is a much greater degree of cytogenetic complexity in the *V. uliginosum* complex than has previously been recognized.

Essentially the entire range of morphological variation of the *V. uliginosum* complex can be observed in Alaskan material, but there is no firm evidence that either $n=12$ diploids or $n=24$ tetraploids occur there. Specimens which are morphologically indistinguishable from $n=12$ Greenland material commonly have a chromosome count of approximately or exactly $n=36$.

Hagerup (1933) indicated that the size and wall thickness of pollen grains might be useful in distinguishing chromosome races of *V. uliginosum*. I studied this possibility in some detail, but found no evidence of any correlation between either wall thickness or tetrad size and level of ploidy. Studies in comparative size and distribution of stomates were also inconclusive.

After examining several hundred specimens, I am forced to conclude that there is no morphological feature or combination of features that can be correlated unequivocably with chromosome races of *V. uliginosum* on a holarctic basis. However, in some cases, a combination of morphological, distribution, and cytological evidence indicates that some races may be characterized, at least in parts of their range, by a particular chromosome number. In the following treatment of the taxonomy of *V. uliginosum*, chromosome numbers are attributed to the subspecies. This indicates that these numbers have been reported from specimens which, on the basis of morphology and/or distribution, are almost certainly members of that subspecies. However, there is no implication that the given number is the only number, or even the most common number, associated with the subspecies in question.

The degree to which chromosome data should be reflected in taxonomy has long been a subject of contention among plant taxonomists. The position adopted by Löve (1951) and others is that differences in chromosome number are certain indications of sterility barriers between closely related populations. Under a rigid application of the biological species concept, these populations would be considered to differ at the species level. Löve (1951) believes that

slight but perceptible morphological differences can usually be found between populations with differing chromosome numbers, and that populations with these characteristics should be recognized as species. Thus, Löve (1954) treats diploid members of the *V. uliginosum* complex as *V. gaultherioides* Bigelow. D. Löve and Boscaiu (1966), on the basis of the supposedly distinctive morphology of *V. gaultherioides*, indicate that the diploid race of the *V. uliginosum* complex is widely distributed in the mountains of Europe, although they cite no cytological data from the area to support their contention. Since some of the Alaskan material with high chromosome numbers is morphologically indistinguishable from $n=12$ material from Atlantic regions, the dangers of extrapolations of this sort are obvious. Although there are probably intrinsic barriers to free interchange of genes between populations of *V. uliginosum* s. lat., lack of knowledge on the location and effectiveness of these barriers makes them useless for taxonomic purposes.

Several recent studies have produced compelling evidence that differences in chromosome numbers between closely related populations do not necessarily constitute insuperable barriers to gene exchange. It has been shown (Lewis, 1967, Marks, 1966) that gene exchange between diploid and tetraploid levels can take place through the production of reduced or doubled gametes, as well as through triploids. It has also been shown (Raven & Thompson, 1964; Dewet, 1965, 1968) that some polyploids may spontaneously revert to diploids. The previously mentioned work of Lewis (1970) indicates that chromosome numbers are not necessarily stable even over short periods of time, and that anomalous chromosome numbers do not necessarily interfere with normal meiosis.

It appears then, that the contention that differences in chromosome number are infallible guides to reproductive isolation and species delineation can no longer be supported either philosophically or theoretically. In *V. uliginosum*, there are no major morphological features that can reliably distinguish members of the various races of the complex

over a broad geographical or ecological range, and there is no sound basis for recognizing more than a single species within the complex.

SYSTEMATIC TREATMENT

The nomenclature used in the following systematic treatment is largely based on older literature in which type specimens were not designated. In other cases, the type specimens have been lost or are unavailable. The names are applied here on the basis of descriptions in the literature in conjunction with studies of more modern specimens collected at, or in the vicinity of the type localities.

Key to the infraspecific taxa of Vaccinium uliginosum L.

a. Leaves pubescent. Diffuse, spreading, stoloniferous shrubs. ..... 1. ssp. *pubescens*

a. Leaves glabrous or faintly puberulent. Growth habit variable.

b. Dwarf, prostrate or matted shrubs; leaves usually less than 10 mm long; dead leaves often persistent on twigs for several years. ..... 2. ssp. *gaultherioides*

b. Robust, often tall grown shrubs, usually of compact, shrubby growth habit.

c. Stomata present only on the lower surfaces of the leaves.

d. Common plant in many areas of northwestern North America and eastern Asia, occurring in a wide variety of habitats. Fruit variable in shape, often sub-cylindrical, highly palatable. ..... 3. ssp. *pedris*

d. Plant of bogs and moorlands of Greenland and western and northern Europe. Fruits spherical, relatively insipid and tasteless. ..... 4. ssp. *uliginosum*

c. Stomates present on both surfaces of the leaves.

e. Plant of low, creeping habit. Leaves mucronate or cuspidate at the apex. Occurring in

alpine situations along the coast of southern Alaska and the Aleutian Islands. ..... 5a. ssp. *occidentale* var. *salicinum*

e. Plant of variable growth habit, usually erect. Leaf apex mucronulate, obtuse or rounded. Occurring in western North America from southeastern Alaska southward. ..... 5b. ssp. *occidentale* var. *occidentale*

Vaccinium uliginosum L. Sp. pl. ed. 1: 350. 1753

1. **V. uliginosum** ssp. **pubescens** (Wormsk. ex Hornem.) comb. nov.

V. pubescens Wormsk. ex Hornem. Fl. Danicae: t. 1516. 1816.

V. uliginosum var. *pubescens* (Wormsk. ex Hornem.) Hornem. Nomencl. Fl. Danicae Emend. 73. 1827.

V. uliginosum var. *alpinum* Bigel. Fl. Bostoniensis ed. 2: 183. 1824.

V. uliginosum var. *Langeanum* Malte, Rhodora 36: 184. 1934.

V. uliginosum var. *alpinum* f. *Langeanum* (Malte) Polunin, Bull. Nat. Mus. Canada 92: 315. 1940.

V. uliginosum f. *pubescens* (Hornem.) Polunin, Bull. Nat. Mus. Canada 92: 315. 1940.

Diffuse, stoloniferous shrub, 1-3 dm tall. Leaves: elliptic or obovate, 10-25 mm long, more or less densely pubescent on both surfaces, apex obtuse, occasionally mucronulate. Flowers: borne singly or in racemes of two or three, 5(4)-merous, corolla white or pink, campanulate or urceolate. Anther horns long, divergent at the base, usually exceeding the tubules. Fruits spherical, 4-6 mm diam., sweet.

This is the most common subspecies of *V. uliginosum* in low arctic tundra and muskeg situations. Throughout most of central Canada and Siberia, this is the only race known to occur. In these areas, populations are uniform and usually densely pubescent. In central Alaska, this subspecies appears to intergrade with ssp. *pedris*, and there are populations there which are variable in terms of leaf pubescence.

Fig. 2. Range of *Vaccinium uliginosum* ssp. *pubescens*. Not included are a number of specimens from Siberia in which the exact collection locations were not given.

Subspecies *pubescens* is the only circumpolar race of *V. uliginosum* (Fig. 2). It is apparently rare in Greenland and northern Europe. Chromosome counts of $n=24$ from New Hampshire (Löve and Löve, 1966) and Russia (Strelkova and Sokolovskaya, 1960) refer to ssp. *pubescens*.

2. **V. uliginosum** ssp. **gaultherioides** (Bigelow) comb. nov.
V. gaultherioides Bigel. (pro parte), New Engl. Journ Medic. & Surg. 5: 335. 1816.

V. uliginosum var. *gaultherioides* (Bigel.) Bigel., (pro parte), Fl. Bostoniensis, ed. 2: 183. 1824.
V. uliginosum **microphyllum* Lange, Meddel. om Grønl. 3: 91. 1880.
V. microphyllum (Lange) Hagerup ex A. Löve, Bot. Not. 103: 49. 1950.

Dwarf, tufted, matted, or procumbent subshrub. Main branches usually prostrate or semi-subterranean, thick, twisted, commonly bearing dense tufts of pale yellowish-brown adventitious twigs. Leaves 5-10 mm long elliptic or obovate, glabrous or with a few fine hairs on the petiole or lower leaf blade, apex obtuse or acute, occasionally mucronulate. Flowers borne singly on pedicels usually less than 2 mm long, 5(4)-merous, corolla pink or white, campanulate or urceolate. Anther horns long, divergent at the base, usually exceeding tubules. Fruits sparse, usually more or less spherical, 2-4 mm diam.

This subspecies is common in alpine and high arctic areas in Greenland, Iceland, eastern Canada, and alpine areas in New England.

Morphologically similar specimens also occur in northern Europe and arctic Alaska and western Canada (Fig. 3). It is not clear whether these specimens should be considered as ssp. *gaultherioides* or as alpine elements of ssp. *uliginosum* and ssp. *pedris*, respectively. All chromosome counts of $n=12$ (see page 441) in *V. uliginosum* refer to ssp. *gaultherioides*.

3. **V. uliginosum** ssp. **pedris** (Harshberger) comb. nov.
V. uliginosum var. *pedris* Harshberger, Proc. Am. Phil. Soc. 67: 232. 1928.

Dense, compact, upright or spreading shrub. Leaves 10-30 mm long, elliptic, obovate or orbicular, glabrous, sometimes puberulent in the more northerly parts of the range; apex obtuse, rounded, truncate, or retuse, occasionally mucronulate. Flowers usually borne in racemes of 2 or 3, on pedicels 3-12 mm long, 5(3, 4)-merous, corolla white or

Fig. 3. Range of *Vaccinium uliginosum* ssp. *gaultherioides*. Squares indicate collection locations of specimens which seem morphologically to belong in this subspecies, but which may be derived from other subspecies.

pale pink, usually campanulate. Anther horns variable, most commonly short, ascending, occasionally obsolete or downward turning, occasionally long and divergent at the base. Fruits variable in shape and size, often subcylindrical or subglobose, abundant and sweet.

This subspecies occurs in a wide variety of habitats in northwestern North America and eastern Asia (Fig. 4). Specimens occurring in muskegs in central and northern Alaska sometimes have slightly pubescent leaves and a rather diffuse growth habit; this may be the result of intergradation with ssp. *pubescens*. Chromosome numbers: $2n=72$ (Hara, 1953), $n=36$ (in some cases) (Young, 1965, unpub.).

4. **V. uliginosum** ssp. **uliginosum**

V. uliginosum L., Sp. pl. ed. 1. 350. 1753.

Erect or spreading shrub. Leaves 10-30 mm long, elliptic or obovate, apex rounded or obtuse; commonly thin and membranaceous, glabrous or occasionally (in northern Europe) slightly puberulent. Flowers usually borne in racemes of two or three on pedicels 3-10 mm long; 5(4)-merous, corolla white, usually campanulate. Anther horns variable,

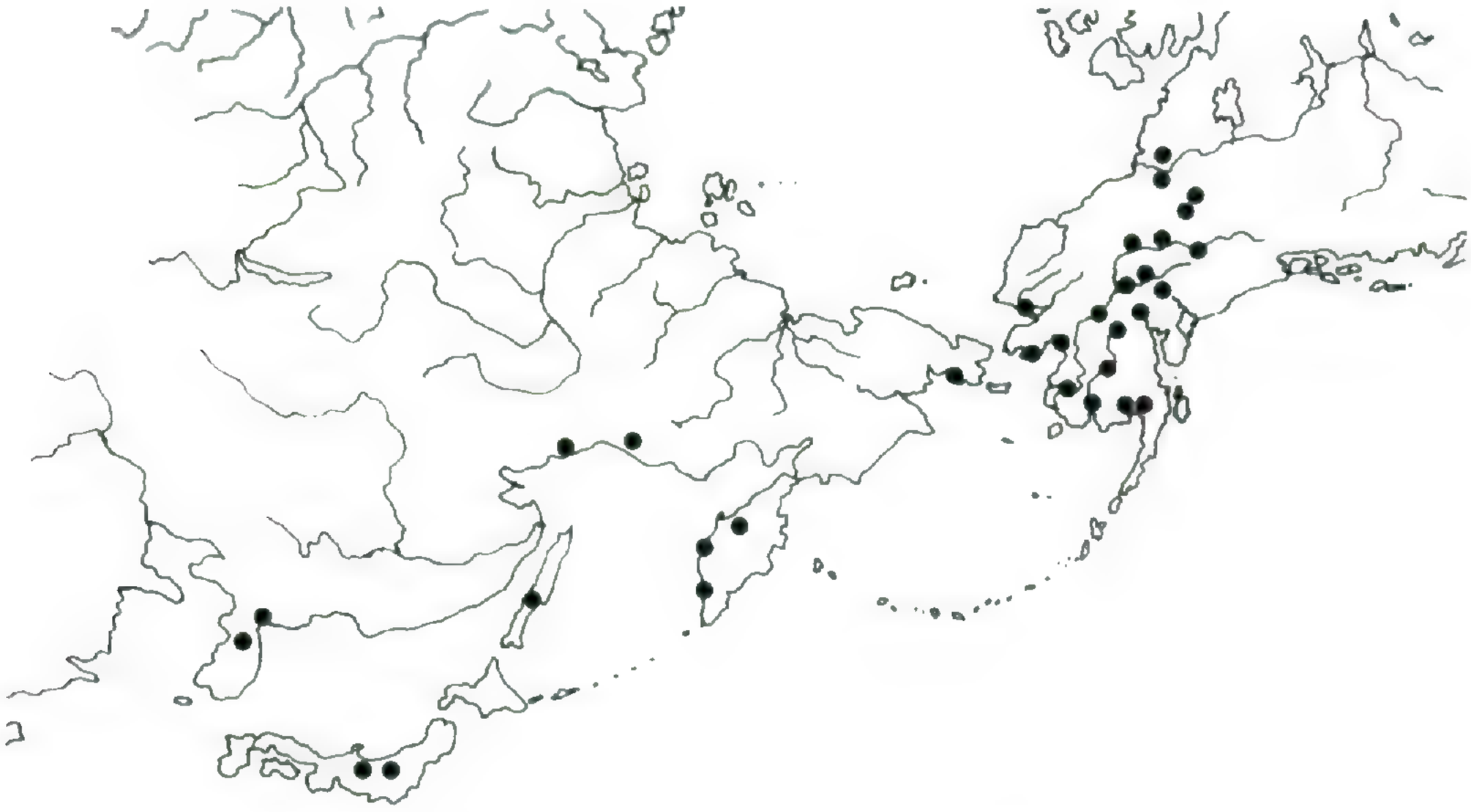

Fig. 4. Range of *Vaccinium uliginosum* ssp. *pedris*.

Fig. 5. Range of *Vaccinium uliginosum* ssp. *uliginosum*.

commonly short and ascending. Fruits spherical, 3-6 mm diam., insipid and not very palatable (Hagerup, 1933, Hulten, 1948).

A fastidious hydrophyte (Hagerup, 1933) occurring in bogs in northern Europe, Iceland, Greenland, and possibly in eastern North America (Fig. 5). Chromosomes: $n=24$ (Hedberg and Hedberg, 1964, Hagerup, 1933).

5. **V. uliginosum** ssp. **occidentale** (A. Gray) Hultén, Ark. Bot. n.s. 7(1): 100. 1968.

Differs from all other subspecies of *V. uliginosum* by having stomates on both upper and lower surfaces of the leaf blade. Two varieties are known; these intergrade in a zone of contact in south central and southeastern Alaska, (Fig. 6).

5a. **V. uliginosum** ssp. **occidentale** var. **salicinum** (Cham.) Hultén, Fl. Aleutian Is. 268. 1937.

V. salicinum Chamisso, Linnaea 1: 525. 1826.

Robust but usually creeping or procumbent shrub. Leaves 5-25 mm long, elliptic, glabrous; apex cuspidate or mucro-

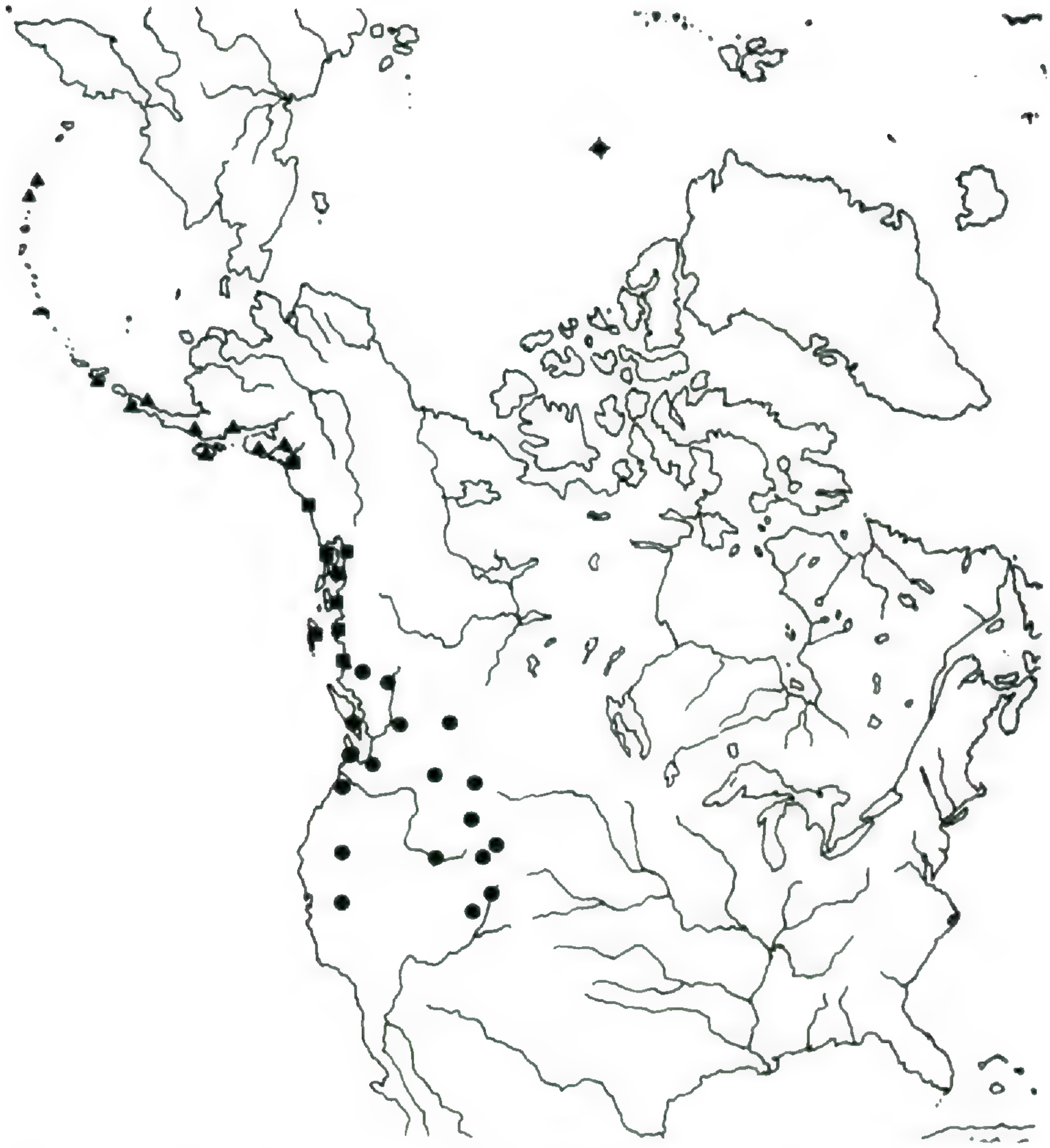

Fig. 6. Range of *Vaccinium uliginosum* ssp. *occidentale*. Triangles represent var. *salicinum*, dots var. *occidentale*, squares represent specimens which are intermediate between the two varieties.

nate. Flowers borne singly on short (less than 2 mm) pedicels, sometimes nearly sessile 5(6, 7)-merous, corolla red or pink, urceolate. Anther horns divergent, longer than tubules. Fruit spherical, 3-6 mm diam.

Occurs in alpine situations along the southern coastal border of Alaska westward to Attu Island.

5b. **V. uliginosum** ssp. **occidentale** var. **occidentale** (A. Gray) Hara, Journ. Jap. Bot. 28: 83. 1953.

V. occidentale A. Gray, Bot. Calif. i. 451. 1876.

Shrub of variable growth habit, usually erect, occasionally spreading in alpine or boggy habitats. Leaves 5-30 mm long, elliptic or obovate, glabrous; apex acute, obtuse or rounded, occasionally mucronulate in the more northern part of the range, where this variety intergrades with var. *salicinum*. Flowers borne singly or in racemes of two or three, length of pedicel variable 1-10 mm; 5(4) merous, corolla pink or white, campanulate or urceolate. Fruits spherical, 3-6 mm diam.

This variety is in many ways the southern counterpart of ssp. *pedris*, which it resembles morphologically in terms of its wide range of morphological variability. However, the fact that all specimens examined had stomata on the upper surfaces of the leaves, while no specimens of ssp. *pedris* showed this character, indicates that var. *occidentale* should be placed in the same subspecies as var. *salicinum*.

Chromosome counts of ssp. *occidentale* var. *salicinum* indicate a variable number, probably including $n=36$, and possibly $n=18$ (Young, 1965, unpub.).

PHYTOGEOGRAPHICAL CONSIDERATIONS

The vast majority of the area presently inhabited by the various races of *V. uliginosum* was repeatedly covered by continental ice sheets during the Pleistocene. The only large unglaciated areas within the northern part of the present range of *V. uliginosum* are in central Alaska and Siberia (Flint, 1957). In southern Europe, western United States, and eastern Asia, the alpine habitats of *V. uliginosum* were glaciated, but populations could easily have persisted in the areas by means of relatively short altitudinal migrations. We may assume that populations of ssp. *pedris*, ssp. *occidentale*, and, perhaps to a lesser extent, ssp. *uliginosum* persisted in parts of their present ranges throughout the glacial maxima of the Pleistocene. These subspecies have extended their ranges considerably in postglacial times, but have only colonized the southern fringes of the Arctic. On the other hand, ssp. *pubescens* and ssp. *gaultherioides* have had immense migrations during postglacial times, and they

have colonized vast areas of the Arctic. Subspecies *pubescens* in particular seems to have great dispersal potential and excellent colonizing abilty, as it has recolonized most of the deglaciated areas in the Arctic and subArctic in both hemispheres.

However, ssp. *pubescens* is not uniformly distributed over the entire arctic region. It is rare or absent in most of the more northern areas customarily referred to as the high Arctic. The varying role of ssp. *pubescens* in the composition of the tundra vegetation is strikingly apparent in northern Alaska. Subspecies *pubescens* (also ssp. *pedris*) is abundant in the northern foothills of the Brooks Range and throughout most of the interior portion of the Arctic Slope, but it is not known to occur along the arctic coast east of Cape Lisburne (Wiggins and Thomas, 1962). Thus there is a narrow belt of land some 500 miles long bordering the Arctic Ocean in northern Alaska in which *V. uliginosum* is not known to occur, although the species is common along the entire southern border of the belt. A similar situation exists in Canada and Siberia; in both cases, ssp. *pubescens* is rare or absent in the islands north of the mainland. In view of the high degree of vagility of ssp. *pubescens*, it must be considered that these northern areas are ecologically unsuitable for this subspecies. It is essentially a low Arctic plant.

Subspecies *gaultherioides* is not as vagile as ssp. *pubescens*, and its main area of colonization is in the Atlantic sector of the Arctic. However, ssp. *gaultherioides* has extended its range considerably beyond that of ssp. *pubescens* in the high Arctic. We can conclude that there are physiological differences between the subspecies which give them differing ability to live and reproduce under the extreme climatic conditions of the high Arctic. In high Arctic areas outside the range of ssp. *gaultherioides*, such as the Siberian Islands, *V. uliginosum* is not represented in the flora.

The history of ssp. *occidentale* seems to be closely intertwined with the glacial history of its range. The present status of this subspecies, with two varieties, can logically

be considered to be the result of at least two periods of glacial advance. Subspecies *occidentale* probably diverged from an ancestral population (ssp. *pedris*?) as a result of separation from the main population by glaciers. The significance of an increase in the number of stomates is not clear, but a correlation of this character with a humid climate is logical, since the number of stomates would have an effect on evapotranspiration. It is reasonable to propose the Pacific Northwest as the area of origin of ssp. *occidentale*. During a later interglacial, ssp. *occidentale* would have extended its range northward along the coast of Alaska, but not into the unsuitably dry environment of central Alaska. During the next period of glaciation, the northern populations of ssp. *occidentale* would have been confined to a few small refugia along the coast of southern Alaska (c.f. Karlstrom & Ball, 1969). These refugial populations would have been subjected to intense pressures by the worsening climate. The result would be the formation of the distinctive and relatively invariable race, var. *occidentale*. As the glaciers retreated once more, this race would have spread out of its relict areas and ultimately come into contact with populations of var. *occidentale* in the vicinity of southeastern Alaska, and hybridization would occur, blurring the lines between the races. There is also a broad zone of contact between the ranges of ssp. *occidentale* and ssp. *pedris*. However, the habitat requirements of these two subspecies are quite different ssp. *pedris* being a plant of muskeg and dry uplands, while ssp. *occidentale* occurs mainly in wet alpine areas. These differences in habitat requirements have probably been instrumental in keeping ssp. *pedris* and ssp. *occidentale* separate. The only area in which there is any evidence of intergradation between these varieties is in the vicinity of Bristol Bay, where an essentially "hybrid" environment prevails.

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HETEROPLOIDY IN SEDUM GLAUCOPHYLLUM

CHARLES H. UHL

In the Crassulaceae differences in chromosome number are common, not only within genera but also often within species (Uhl, 1961). In many cases these differences take the form of a polyploid series among related species or within what, by the usual taxonomic criteria, appears to be the same species. Many cases of dysploidy also are known. In some cases because of extensive dysploidy even the basic or ancestral chromosome number cannot be determined with any confidence.

The species of *Sedum* native to the eastern United States offer several examples of heteroploidy, including both polyploidy and dysploidy. Baldwin has reported on the cytogeography of polyploidy in *S. ternatum* (1942b) and in *S. pulchellum* (1943). Uhl (1952) reported dysploidy in *S. rosea (sensu lato)*, which includes a circumboreal race with $n=11$ and a North American race with $n=18$, both of them occurring in New York state. This paper reports the presence of heteroploidy, including both polyploidy and dysploidy, in *S. glaucophyllum*, with brief discussions of distribution and possible origin and of the chromosomes of some related species.

R. T. Clausen (1946) described *S. glaucophyllum* for plants of western Virginia and adjacent areas. The type locality is Mountain Lake, Giles Co., Virginia. Previously these plants had usually been identified as *S. nevii* Gray, a species which was originally based on plants from Alabama. *Sedum beyrichianum* Masters represents an earlier recognition of two taxa here, but only described *S. nevii* again (Clausen, 1946).

Sedum glaucophyllum is generally coarser than *S. nevii (sensu stricto)*, with slightly broader, more glaucous leaves in denser rosettes. Separation of the two as species was supported by earlier reports of a difference in chromosome number, $n=6$ in plants from Alabama and $n=14$ in plants

from Virginia, including some from Mountain Lake (Baldwin, 1942a). Clausen (1946, 1949) has given detailed descriptions and a taxonomic history of the two species.

MATERIALS AND METHODS

Plants were collected sporadically between 1946 and 1968 and grown at Ithaca, New York. Their localities are mapped in Fig. 17 and listed in Table 1, arranged by counties, roughly from north to south and then from east to west. Conventional aceto-carmine squash preparations were made of meiosis in the pollen mother cells; the slides were studied and then made permanent. In most cases only one plant of a population was studied cytologically. In 13 of the 15 cases where two or more plants from the same population were studied the same number of chromosomes was found. One exception to this rule was an obvious case of chromosome doubling; the other involved apparent hybrids between the two principal chromosome races. The photographs (Figs. 1-16) are from permanent preparations, ×2000. Voucher specimens of most collections are in the Wiegand Herbarium of Cornell University.

CYTOLOGY

Sedum glaucophyllum contains three chromosome races, with gametic numbers of 14, 22, and 28 (Figs. 1-4). Throughout the range, in all chromosome races, several large, mostly metacentric bivalents are conspicuous. The 14-chromosome race has one long metacentric bivalent and two that are slightly shorter (Figs. 1, 2). The 22-chromosome race has two long metacentric bivalents and three others that appear as considerably shorter rods, only about half as long (Figs. 3, 5, 6). In both races the remaining, smaller bivalents differ among themselves somewhat in size, but none are sufficiently distinctive to be consistently identified at meiosis. Thus the karyotypes of these two races differ not merely in number alone, but also in the structure of some of the longer chromosomes.

The large bivalents of *S. glaucophyllum* are very unusual

among the Crassulaceae, where as a general rule all bivalents look essentially round at meiotic metaphases and where usually no bivalents can be consistently identified. Baldwin (1942a), who found only the 14-chromosome race, figured the large chromosomes in root tip cells, but his interpretation apparently differs somewhat as to their number and form from that presented here, which is based strictly on meiotic material.

The race with $n=28$ bears six pairs of larger chromosomes, instead of three. Clearly these plants must have originated by chromosome doubling in an ancestor with $n=14$. This race was found only in a small area a few miles east of Clifton Forge, Virginia, along the lower Cowpasture River and on North Mountain to the east. Univalents and occasional multivalents are present in some metaphase I figures, and lagging chromosomes at anaphases I and II. The number of dyads on the metaphase II plates also seems to vary occasionally, as might be expected. This race has all of the cytological earmarks of an autotetraploid.

Only a few miles to the west, 8 miles north-northeast of Covington, a population was found (U268) that included plants with $n=22$ and $n=44$, another obvious case of chromosome doubling. The same sort of meiotic irregularities were seen in the plants with $n=44$ as in the ones with $n=28$.

Several other plants represent more or less accidental variants from the standard. One collection (U575) con-

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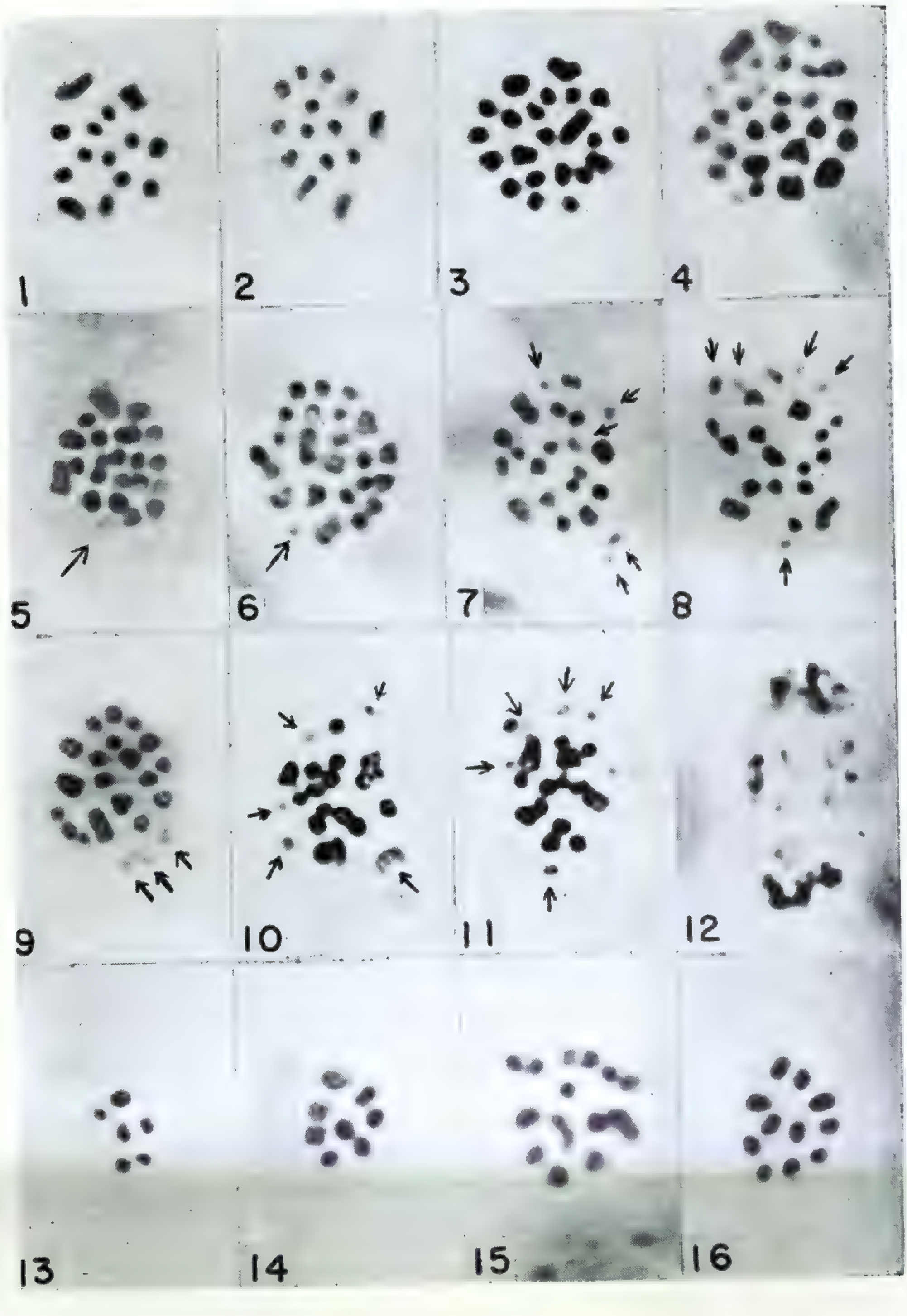
Figs. 1-16. Chromosomes in pollen mother cells at metaphase I (except Fig. 12), ×2000. Arrows identify univalents. Figs. 1-12. *Sedum glaucophyllum*. Figs. 1, 2. U788, $n=14$. Fig. 3. U785, $n=22$. Fig. 4. U515, $n=28$. Fig. 5. U575, $n=21_{II}+1_{I}$. Fig. 6. U560, $n=22_{II}+1_{I}$. $+5_{I}$. Fig. 9. Figs. 7, 8. U451, $n=17_{II}$ U549, $n=19_{II}+3_{I}$. Figs. 10, 11. U787A, $n=15_{II}+5_{I}$ (1 large and 4 small univalents. One bivalent slightly out of focus at right in Fig. 11). Fig. 12. U787A, Anaphase I, with 4 of 5 lagging univalents in focus and dividing equationally. Fig. 13. U1672. *S. nevii*, $n=6$. Fig. 14. U751, *S. ternatum*, $n=8$. Fig. 15. U450, *S. ternatum*, $n=16$, with some secondary associations (top, lower center and right). Fig. 16. U1128, *S. pulchellum*, $n=11$.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sistently had 21 bivalents and a small univalent at metaphase I (Fig. 5), and is considered to represent a monosomic ($2n$-1) plant. In two other collections (U560, U767) an extra unpaired chromosome was seen in some cells (Fig. 6). In other cells it presumably contributed to the formation of a trivalent, though this could not be identified. These plants are considered to be trisomics ($2n+1$) for one of the smaller chromosomes in the set.

The most interesting cytological variants are some apparent descendants of natural hybrids between the 14- and 22-chromosome races, collected in three different years at the south end of a limestone bluff along the North Fork of the Shenandoah River near Woodstock, Virginia (U451, U549, U787A). Seven other plants (U787B-H), spaced 40 to 150 yards apart to the north along the bluff, all had n=14. The closest plant (U787B), 40 yards north, had chromosome bridges in many cells at anaphase I, suggesting that it was heterozygous for an inversion that may have been introduced by the hybridization. The closest other population known to this had n=22 (U763). It was found about 9 miles west, or 16 miles upstream by way of the river and its tributary, Stony Creek.

Four of these putative hybrids have been studied cytologically and no two of them are the same. Exact interpretations are difficult, but the first collection (U451) included two different cytological types. One most often had 14 bivalents and 3 univalents at metaphase I and probably resulted from a backcross of a hybrid to the 14-chromosome race. The other was most often interpreted as forming 17 bivalents and 5 univalents, including 3 very small ones, at metaphase I (Figs. 7, 8). This plant is considered to have resulted from a backcross of the hybrid to the other, 22-chromosome parent. Still another plant (U549) was interpreted as having 19 bivalents and 3 univalents, including 2 small ones and a slightly larger metacentric (Fig. 9). This apparently resulted from a different backcross to the 22-chromosome parent.

The fourth putative hybrid (U787A) apparently formed

15 bivalents and 5 univalents, including 4 small ones and a large one, at metaphase I (Figs. 10-11). Such a plant could arise theoretically by union of a gamete bearing 14 + p chromosomes with another bearing 14 + q chromosomes, where $p + q = 7$ and includes two chromosomes that pair with each other and 5 more that do not. Gametes of these types would be expected from an F_1 hybrid between the 14- and the 22-chromosome races, or from certain of its later-generation progeny. In this hybrid (U787A), anaphase I usually showed 5 laggards, one of them large, as would be expected from the usual number of univalents (Fig. 12).

Although no plant studied was considered to be an F_1 hybrid, from the plants that were studied it seems likely that spores and gametes produced by the F_1 must bear various chromosome numbers between 14 and 22. This implies that pairing in the F_1 brings 14 of the chromosomes from the 22-chromosome parent into association with the 14 chromosomes of the other race, and the remaining 8 chromosomes are distributed more or less at random, either because they enter into the formation of multivalents or because they fail to pair and remain as univalents. Conceivably, this unstable cytological situation might eventually evolve a stable race with still another chromosome number. In fact, it may offer clues to the origin of the 22-chromosome race, e.g., from the progeny of a fertile triploid of the 14-chromosome race.

Morphologically all three chromosome races are very similar and clearly would be assigned to the same species. Detailed studies of *Sedum glaucophyllum* are being made by my colleague, Professor R. T. Clausen. His work should reveal whether any consistent morphological distinctions can be made among the chromosome races.

Several other small species of *Sedum* of eastern United States also have 4-parted, more or less white flowers and have often been confused with *S. glaucophyllum*. Besides *S. nevii*, these include particularly *S. ternatum* and *S. pulchellum*. Cytologically these are all distinct from each other and from *S. glaucophyllum*.

Clausen (1949) reported that true *S. nevii* was known at only three localities, two in Alabama and one in southeastern Tennessee. During these studies a fourth locality was discovered on rocks along the east side of the Chattahoochee River below Goat Rock Dam, above Columbus, Georgia (U339, U624). I believe this is the first record of the species from Georgia. Meiotic chromosomes of the species appear similar at all four localities, with none of the 6 bivalents consistently distinctive or showing the elongate form of the large bivalents in *S. glaucophyllum*.

Although *S. ternatum* now is more widely distributed, it probably is native only from southern Pennsylvania to Indiana and Alabama. Baldwin (1942) has published a map showing the distribution of 71 plants with $2n = 16$, 24 (triploid), 32 and 48. Throughout most of its range only the tetraploid ($n=16$, $2n=32$) was found. Diploid plants ($n=8$, $2n=16$) were restricted to a rather narrow belt about 150 miles long on both sides of the border of Virginia with West Virginia and Kentucky, an area in which tetraploids also occurred. The only hexaploid ($2n=48$) was from Alabama, where otherwise only tetraploids were found.

In connection with the present work, chromosomes of 81 more collections of *S. ternatum* were studied, including 15 diploids ($n=8$, Fig. 14), 2 triploids, and 64 tetraploids ($n=16$, Fig. 15). These extend the known range of the diploid 100 miles farther to the northeast (Fig. 17), but otherwise conform closely to the distribution of the chromosomal strains reported by Baldwin. The similarity in morphology between diploid and tetraploid *S. ternatum* and the occurrence of multivalents at meiosis in the tetraploid led Baldwin (1936) to suggest that it is an autotetraploid. Once again, the present study supports Baldwin's conclusions. Metaphase I figures (Fig. 15) usually include close secondary associations, multivalents and occasionally univalents, and some metaphase II plates show as few as 13 or as many as 19 elements, due to unequal distribution during anaphase I.

Baldwin (1944) suggested that 14-chromosome *S. glauco-*

phyllum (which was the only form he knew, and which he called *S. beyrichianum*, the correct name being not yet available) arose by amphidiploidy between true *S. nevii* (*n*=6, Fig. 13) and diploid *S. ternatum* (*n*=8, Fig. 14). *S. ternatum* has much broader leaves than *S. glaucophyllum*, and they are generally in whorls of 3. Although *S. glaucophyllum* is more like *S. nevii*, it differs somewhat in the direction of *S. ternatum* (Clausen, 1949). This can be construed as supporting Baldwin's hypothesis of an amphidiploid origin for *S. glaucophyllum*.

The next question concerns the origin of the 8 chromosomes by which the two principal races of *S. glaucophyllum* differ. In this regard, Baldwin's suggestion leads to an obvious second theoretical possibility: that the 22-chromosome strain of *S. glaucophyllum* may have arisen in similar fashion, either by a second amphiploidy between 14-chromosome *S. glaucophyllum* and diploid *S. ternatum* (*n*=8) or directly between *S. nevii* (n=6) and tetraploid *S. ternatum* (*n*=16, Fig. 15). In either case, the 22-chromosome strain of *S. glaucophyllum* would be an autoallopolyploid (NNTTTT), since it would bear two sets of chromosomes from *S. ternatum* (T) for each one of *S. nevii* (N). It would therefore be expected to resemble the former more closely than the latter. This is not the case.

Multivalents are common in tetraploid *S. ternatum*, but in 22-chromosome *S. glaucophyllum* they are not ordinarily seen. Also, in the putative descendants of hybrids between the 14- and 22-chromosome races of *S. glaucophyllum* the extra chromosomes presumably represent some of the 8 chromosomes by which the races differ. However, these seem to show little or no tendency to enter into multivalent formation, as might be expected if they had 8 homologues (or homoeologues) in the complement of 14-chromosome *S. glaucophyllum*.

The 8 chromosomes by which the two principal races of *S. glaucophyllum* differ are mostly small and not distinctive. The hypotheses of amphiploidy hold that these chromosomes must have come from *S. ternatum*. However, although there

is some range in size among the chromosomes of *S. nevii* and *S. ternatum* (Figs. 13, 14), neither species is characterized by any meiotic bivalents as distinctive as the longest ones in *S. glaucophyllum*. (Compare also figures of somatic and meiotic chromosomes in the three species in Baldwin, 1936, 1942a).

Since the large, distinctive chromosomes of *S. glaucophyllum* occur in all collections of all races, either their origin must have coincided closely with that of the species or they must have been introduced from some ancestral species. But no other species of eastern North America has chromosomes that look like these. Thus, if *S. glaucophyllum* arose as an amphidiploid, as proposed by Baldwin (1944), it is not a simple, straightforward case.

The chromosome numbers are compatible with the hypotheses of amphiploidy, but the form and behavior of the chromosomes and the morphology of the plants do not fit very well. Some repatterning of the karyotype, mostly by translocations, would also be required at about the same time to account for the long chromosomes of *S. glaucophyllum*. Probably some rebalancing of the genotype also would be necessary to account for the closer resemblance of all chromosome races to *S. nevii* rather than to *S. ternatum*. Determinations of the amounts of DNA that characterize the chromosome complements of these various species and races should provide a good test of the hypotheses of amphiploidy.

In 1948, Dr. Robert E. Lee, of Cornell, produced an artificial hybrid between 14-chromosome *S. glaucophyllum* (Clausen 6795) and *S. nevii* ($n=6$). My slides of this are not good enough for a definitive cytological analysis, but somatic metaphases in anther walls have about the 20 chromosomes expected. Meiotic metaphase I has about 8 to 12 elements, including some large and complicated multivalents and a variable number of univalents. The simplest interpretation of the multivalents is that in some cases a chromosome of *S. nevii* synapses at different places along

its length with two or more chromosomes of *S. glaucophyllum*.

The range of *S. ternatum* today includes most of the range of *S. nevii* and all the range of *S. glaucophyllum*, but the last two species are separated by a gap of 250 miles. Opportunities for natural hybridization may have been offered during cooler, glacial times, when presumably more southerly distributions prevailed.

Sedum glaucophyllum and *S. ternatum* were found together at 11 localities. Tetraploid *S. ternatum* ($n=16$) was found with the 14-chromosome strain of *S. glaucophyllum* at five places, with the 22-chromosome strain at four, and with the 28-chromosome strain at one. Triploid *S. ternatum* ($2n=3x=24$), which probably implies the presence of the diploid nearby, was found once with 22-chromosome *S. glaucophyllum*. Although the range of *S. glaucophyllum* overlaps much of the range of diploid *S. ternatum*, the two were never found together. Possibly it is worth looking for localities where both diploid *S. ternatum* ($n=8$) and *S. glaucophyllum* occur together, and, if they are found, to determine whether both species are stable there.

The mostly winter-annual species, *S. pulchellum*, especially in its juvenile form, is very similar to *S. nevii* and *S. glaucophyllum* (Clausen, 1949). To the south, distribution of *S. pulchellum* overlaps that of *S. nevii*, but it is separated from *S. glaucophyllum* by about 150 miles at the closest. Baldwin (1943) mapped the distribution of 45 collections of *S. pulchellum*, representing diploid ($n=11$), tetraploid ($n=22$) and hexaploid ($n=33$) chromosome races. The 12 additional collections of this species that I have studied represent all 3 chromosome races and conform in distribution to Baldwin's map. The 22-chromosome (tetraploid) race of *S. pulchellum* lacks the distinctive large chromosomes of the 22-chromosome race of *S. glaucophyllum*. Their chromosome numbers and karyotypes must have evolved in different ways, and their similarity in number is merely coincidence.

ECOLOGICAL OBSERVATIONS

Efforts to correlate the distribution of the chromosome races of *S. glaucophyllum* with the geology and with the drainage history of the area have so far not been very productive. Much of the range of the species is an area of long, parallel anticlinal and synclinal ridges and valleys. It has a history of stream piracy as the headwaters of streams that flow more directly eastward, notably the James and Roanoke Rivers, have captured tributaries from streams with longer courses, notably the New and Potomac Rivers (Wright, 1934).

No clear correlation of distribution with drainage is apparent. The greatest concentration of the 22-chromosome race is in, or on the borders of, the James River drainage, where 68 of its 81 localities occur (Fig. 17). However, 18 of the 65 localities of the 14-chromosome race also are in the James basin, 12 of them in its southern part, which may earlier have belonged to New River drainage (Wright, 1934). But five of them, and the four localities of the 28-chromosome strain, are in the heart of the James River drainage, near or along its tributary, the Cowpasture River. In regions contiguous to the James River basin, the 22-chromosome race was found to the west at 7 localities in West Virginia in drainage of the Greenbrier River, a tributary of the lower part of the New River, and to the northeast at two localities in drainage of the Middle River, an upper tributary of the South Fork of the Shenandoah. The only really disjunct localities of the 22-chromosome race are 3 near the North Fork of the Potomac River, southwest of Cumberland, Maryland, and one in western Shenandoah County on Stony Creek, a tributary of the North Fork, Shenandoah River.

The 14-chromosome race of *S. glaucophyllum* is more widely distributed, especially in the north, where it predominates, and in the south, where the 22-chromosome race is unknown. Forty-seven of its 65 localities are outside the James River drainage, 19 to the south and south-

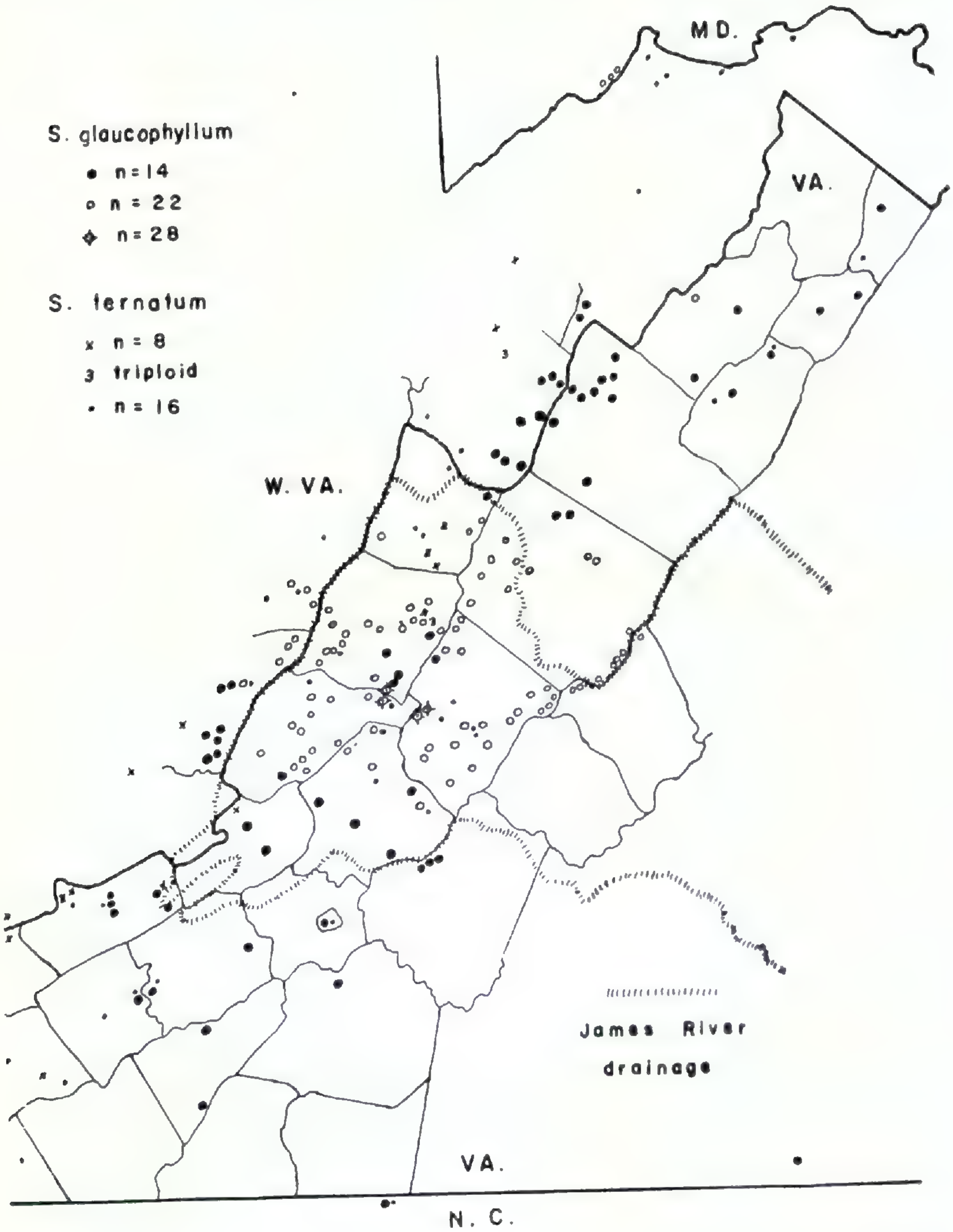

Fig. 17. Distribution of chromosome races of *Sedum glaucophyllum* and *S. ternatum* in western Virginia and adjacent regions. Three localities for *S. glaucophyllum* are from Baldwin (1942a). Localities for *S. ternatum* are from Baldwin (1942b) and Uhl (unpublished).

west, and 28 to the north. It occurs sporadically along the crest of the Blue Ridge, from Rocky Knob (Floyd Co.) north to Peaks of Otter (Bedford Co.). Farther north, the crest of the Blue Ridge bears the 22-chromosome race from east of Lexington to near Waynesboro.

At several places the two races occur within a few miles of each other, sometimes in the same stream valley. Thus, the upper valley of Anthony Creek, north of White Sulphur Springs, West Virginia, is occupied by the 22-chromosome race (U573, U574, U575, U577) for more than 10 miles; then, farther down, where the stream begins to cut through Hopkins Mountain, and separated by an interval of no more than 2 miles, the 14-chromosome race occurs (U578, U579). On the Cowpasture River at Millboro Springs, Bath Co., the 14-chromosome race (U472) is only 4 miles south of two localities of the 22-chromosome race farther upstream (U772, U774), and 5 miles west of it at Panther Gap (U330). Nearby, along Bratton Creek, southwest of Goshen, collections of the 14- and 22-chromosome races (U779, U780) are separated by only 2.3 miles in what appears from the topographic map (Millboro 15′ sheet, USGS) to be the same stratigraphic situation. These last two cases appear to be on the boundary between a pocket where the 14- and 28-chromosome races are surrounded by the 22-chromosome race (Fig. 17).

In the valley of Potts Creek, southwest of Covington, Virginia, again with apparently the same stratigraphy, the 14-chromosome race (U596) is separated from the 22-chromosome race (U595) by only 5 miles. In Botetourt Co., Virginia, between Buchanan and Natural Bridge, no more than 4 miles separate the 14-chromosome (U510) and 22-chromosome (U508) races. Doubtless some of these intervals could be reduced by further collecting, and the areas may be worth searching for possible hybrids between the two races.

The occurrence of *S. glaucophyllum* seems clearly related to humidity and to the availability of moisture. At lower elevations it is found chiefly on shady bluffs along streams,

but at higher elevations it occurs in rocky places more generally. Both chromosome races were found most often on shale and limestone, but both occur on quartzitic rock along the crest of the Blue Ridge or even on sandstone. Generally the species is absent from more acid environments.

In elevation, the 14-chromosome race was found from 200 feet, near South Hill, Virginia (*Clausen* & *Uhl* 6801), to about 3900 feet or more, at the type locality, Mountain Lake, Virginia, with a mean elevation for 47 localities of 1677 feet. The 22-chromosome race ranges from 750 feet, on the Maury River, near Glasgow (U603), to 3320 feet on the Blue Ridge Parkway north of Tye River Gap (U607), with a mean for 80 localities of 1726 feet. The four localities of the 28-chromosome race range from 1150 feet along the Cowpasture River (U326) to 2680 feet on North Mountain (U515), mean 1825 feet. The chromosome races obviously do not differ from each other in their altitudinal distributions.

No effort is made here to relate distribution of the chromosome races with remnants of the ancient Appalachian peneplains, the Schooley, the Harrisburg, etc. (Wright, 1934). The species occurs mostly on steep rocky slopes and bluffs. Generally these are young and transient topographic features, but because of recent uplift they are now found at all elevations on the old erosional surfaces. The fact that both chromosome races occur, though at different places, on perhaps the oldest land surface of all, the crest of the Blue Ridge, appears to argue against a relation between age of the land exposure and distribution of the chromosome races.

More likely the true centers of concentration of the species are at higher elevations along the ridges, where there are fewer roads and where fewer collections were made. Populations on stream bluffs at lower elevations probably originated from these. A better view of distribution of the chromosome races might therefore be based on ridges, rather than on drainage basins. However, except for the Blue Ridge, because of the Parkway, not enough collections

have been made on the ridges to test this idea. Perhaps the valleys cited above, where two chromosome races occur close together, lie between ridges that bear the different races.

Soil with 11 collections of the 14-chromosome strain of *S. glaucophyllum* ranged in pH from 5.65 to 7.75, with a mean of 6.84. For 40 collections of the 22-chromosome strain, the range was pH 5.25 to 8.0, with a mean of 6.54. With so much overlap, the difference of only pH 0.3 in the averages seems not significant. For *S. ternatum* in the same area, soil with 3 diploids (n=8) ranged from pH 6.0 to 7.4, mean 6.62; for 8 tetraploids (n=16), the range was 6.4 to 7.55, the mean 6.91. These values also do not seem significantly different from each other or from those for *S. glaucophyllum*.

Thus no simple differences in their ecology have been found between the 14- and the 22-chromosome races. Both occupy the same sort of habitat and exhibit the same preferences and tolerances with respect to substrate, acidity and elevation. Probably they compete with each other.

Whatever its origin, because of its chromosome number the 22-chromosome race of *S. glaucophyllum* must have appeared later than the 14-chromosome race. Thus the fact that the former predominates in the heart of the range of the species as a whole suggests that it may have largely replaced the 14-chromosome race there. The 14-chromosome race is mostly peripheral in its distribution, supporting the conclusion that it is older. An experiment to test the survival of the two races in competition with each other under various conditions might give interesting results.

SUMMARY

Study of 180 plants of *Sedum glaucophyllum* from 150 localities reveals chromosome races with n=14, n=22, and n=28. All races have several distinctive bivalents that are longer than any known in other American species. Apparent hybrids between the 14- and 22-chromosome races were

found at one locality. The race with $n=28$ is a local autotetraploid derived from $n=14$.

Baldwin's hypothesis that *S. glaucophyllum* with $n=14$ originated as an amphidiploid between *S. nevii* ($n=6$) and diploid *S. ternatum* ($n=8$) leads to a suggestion that a second amphiploidy, between plants with $n=14$ and $n=8$, may have produced the race with $n=22$. These hypotheses are in good accord with the chromosome number, but chromosome morphology and behavior and the morphology of the plants do not fit well. Some restructuring of the karyotype and rebalancing of the genotype would also be necessary.

The chromosome races of *S. glaucophyllum* do not differ significantly in their tolerances or preferences in substrate, pH, elevation, or general habitat. However, predominance of the 22-chromosome race in the center of the range gives the impression that it has been replacing the 14-chromosome race there.

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Table 1. Collections of *Sedum glaucophyllum* Studied and Their Chromosome Numbers.

Maryland. ALLEGANY COUNTY: U749 Fort Hill, 0.4 mi. W. of Rawlings, on bluff, 770′ (*n*=22); U748, *R. T. Clausen* 7012 Potomac River bluff, 0.5 mi S. of Rawlings, 790′ (*n*=22); U750 Bluff at SW end of Fort Hill, 4 mi. NE of McCoole, 760′ (*n*=22).

West Virginia. HARDY COUNTY: U649 Moorefield River, 2.5 mi. S. of Bass (*n*=14); U648 Moorefield River, 5.7 mi. S. of Bass (*n*=14). PENDLETON COUNTY: U755 7½ mi. E. of Fort Seybert, 2.1 mi. W. of Sand Spring Gap, 2595′ (*n*=14); U647 Rough Run, 4 mi. E. of Fort Seybert (*n*=14); U646 Fisher Run, 1½ mi. NE. of Fort Seybert, 1500′ (*n*=14); *R. T. Clausen* 47-118 Shenandoah Mt., summit (*n*=14); U645 Moorefield River, 2.9 mi. S. of Brandywine, 1650′ (*n*=14); U644 1.3 mi. (*n*=14); U553 5.3 mi. E. of Sugar Grove, 2900′ (*n*=14); U554 Moorefield River, 0.6 mi. NW of Sugar Grove, 2500′ (*n*=14); U522, U572 Laurel S. of Sugar Grove, (*n*=14). POCAHONTAS COUNTY: Creek, near Rimel, 2400′ (*n*=22); U641 Knapp Creek, 0.8 mi. SE of Huntersville (*n*=22); U570 Knapp Creek, 1½ mi. NW of Huntersville, 2250′ (*n*=22). GREENBRIER COUNTY: U573 Anthony Creek, 3.2 mi. S. of Pocahontas County line, 2200′ (*n*=22); U574 Anthony Creek, 5.3 mi. S. of Pocahontas County line, 2150′ (*n*=22); U575 Anthony Creek, 9.3 mi. S. of Pocahontas County line, 0.7 mi. NE of Neola, 2045′ (*n*=21+1); U577 Anthony Creek, 0.5 mi. NW of Camp Wood and 1 mi. NW of Alvon, 1950′ (*n*=22); U578 Anthony Creek, at Blue Bend Park, 2.5 mi. W. of Camp Wood, 1945′ (*n*=14); U579 Anthony Creek Gorge, 2.2 mi. NE of Anthony, 1870′ (*n*=14); U580 Wades Creek, 1.1 mi. E. of White Sulphur Springs, 1920′ (*n*=14); U291 Near summit of Kates Mountain, S. of White Sulphur Springs (H. D. Bennett), 3000′± (*n*=14); U640 Dry Creek, 2.9 mi. SE of White Sulphur Springs, 1975′ (*n*=14); U639 Dry Creek, 6 mi. S. of White Sulphur Springs, 2125′ (*n*=14); U638 Tuckahoe Run, 7.5 mi. S. of White Sulphur Springs, 2250′ (*n*=14).

Virginia. CLARKE COUNTY: Boyce (*Baldwin*, 1942) (*n*=14). WARREN COUNTY: U788 Shenandoah River, 8 mi. ENE Front Royal, 480′ (*n*=14); U547 Lime sink 1½ mi. SW of Front Royal, 560′ (*n*=14). SHENANDOAH COUNTY: U451, U549, U787A N. Fork, Shenandoah River opposite junction of Narrow Passage Cr., 3 mi. SW of Woodstock, 765′ (Irregular); U787B, C, D, E, F, G, H (7 plants) Same locality (*n*=14); U763 Stony Cr. bluff, 1.3 mi. E. of Liberty Furnace, 1040′ (*n*=22); U1669 N. Fork, Shenandoah River, 5 mi. N. of New Market, 920′ (*n*=14). PAGE COUNTY: *R. T. Clausen* 6747A, B, C, D,

E, F, G, H (8 plants) on limestone, near Rileyville (n=14); U550 S. Fork, Shenandoah River, 5 mi. SW of Luray (n=14). ROCKINGHAM COUNTY: U760 German River, 4.4 mi. N. of Fulks Run, 1280′ (n=14); U332 German River, just N. of Fulks Run, 1200′ (n=14); U764 Shoemaker River, 3.0 mi. S. of Genoa, 1240′ (n=14); U759 Little Dry River, 3.2 mi. W. of Fulks Run, 1360′ (n=14); U758 Little Dry River, 6.1 mi. W. of Fulks Run, 1560′ (n=14); U757 7.8 mi. W. of Fulks Run, 4.9 mi. E. of Sand Spring Gap, 1800′ (n=14); U756 1.9 mi. E. of Sand Spring Gap, 2925′ (n=14); U765 Dry River, 2.9 mi. W. of Hinton, 1460′ (n=14); *R. T. Clausen* 6992 Shenandoah Mt., near Summit, 3470′ (n=14). AUGUSTA COUNTY: U552 Natural Chimneys, 0.7 mi. N. of Mt. Solon, 1380′ (n=14); U766 1.5 mi. W. of Mt. Solon, 1400′ (n=14); U767 Middle River, 2.4 mi. N. of Verona, 1280′ (n=22+1); U610 Middle River, 3.2 mi. N. of Verona, 1360′ (n=22); U768 E. side, Crawford Mt., 3.6 mi. NW Buffalo Gap, 2520′ (n=22); U769 W. side, Crawford Mt., 4.8 mi. W. of Buffalo Gap, 2360′ (n=22); U565 Calfpasture River, 1.0 mi. S. of Lebanon, 1875′ (n=22); U564 Calfpasture River, 2.8 mi. NE of Deerfield, 1750′ (n=22); U563 Calfpasture River, 2.1 mi. S. of Deerfield, 1650′ (n=22); U770 Great North Mt., 6.4 mi. SE of Deerfield, 2560′ (n=22); U562 Calfpasture River, 1.8 mi. S. of Marble Valley, 1580′ (n=22); U609 Humpback Gap, Mile 6, Blue Ridge Parkway, 2375′ (Nelson County) (n=22); U531 Humpback Rocks, S. of Mile 6, Blue Ridge Parkway, 2200′ (n=22); U530 Ravens Roost, Mile 10.7, Blue Ridge Parkway, 2900′ (n=22); U225, U529 W. of Laurel Springs Gap, Mile 11.3, Blue Ridge Parkway, 3000′ (n=22); U224 Mile 13, Blue Ridge Parkway (n=22); U528 Mile 16.3, Blue Ridge Parkway (Nelson County), 2700′ (n=22); U608 2.4 mi. W. of Love, Mile 18, Blue Ridge Parkway, 2700′ (n=22). NELSON COUNTY: U214, C47-98 6 mi. NE of Tye River Gap, Mile 21, Blue Ridge Parkway (n=22); U607 2.4 mi. N. of Tye River Gap, Mile 24.8, Blue Ridge Parkway, 3320′ (n=22); U527 1.3 mi. N. of Tye River Gap, Mile 25.9, Blue Ridge Parkway, 3175′ (n=22). HIGHLAND COUNTY: U555 Moorefield River at Palo Alto, 0.3 mi. S. of W. Va. line, 2160′ (n=14); U525, U566 Shenandoah Mt. summit, on Confederate earthworks, 9.8 mi. E. of McDowell, 2950′ (n=22); U567 0.4 mi. S. of Headwaters, 2050′ (n=22); U523 Townsman Draft, near Back Creek, 3.9 mi. SW of Mill Gap, 2300′ (n=22). ROCKBRIDGE COUNTY: U606 6.6 mi. S. of Tye River Gap, Mile 33.8, Blue Ridge Parkway, 3250′ (n=22); U526 1.7 mi. NE of Irish Gap, Mile 35.7, Blue Ridge Parkway, 2800′ (n=22); U605 1.2 mi. E. of Irish Gap, Mile 36.2, Blue Ridge Parkway, 2650′ (n=22); U621, U786 Little Marys Creek, 0.8 mi. E. of Vesuvius, 1550′ (n=22); U785 South River, 3.8 mi. SW of Vesuvius, 1250′ (n=22); U784 South River at bridge, 1.5 mi. NE of Cornwall, 1050′ (n=22); U783 South River at Cornwall, 1025′ (n=22); U782 South River at gaging

sta., 4.5 mi. E. of Lexington, 920′ (*n*=22); U604 Maury River, W. side of Buena Vista, 875′ (*n*=22); U449 E. of US 11 Highway bridge, N. side of Lexington, 900′ (*n*=22); U864, U1635 5 mi. S. of Lexington, 1030′ (*n*=22); U603 Maury River, E. of Lone Jack Quarry, 2½ mi. NW of Glasgow, 750′ (*n*=22); U602 Cedar Creek at Gilmore Mills, ca. 1 mi. below Natural Bridge, 760′ (*n*=22); U512 S. Buffalo Creek, ca. 8 mi. SW of Murat, 1200′ (*n*=22); U511 S. Buffalo Creek, ca. 8.3 mi. SW of Murat, 1220′ (*n*=22); U561 Calfpasture River, 0.6 mi. S. of Augusta County line, 1530′ (*n*=22); U560 Calfpasture River, 6 mi. N. of Goshen, 1480′ (*n*=22); U781 Calfpasture (=Maury) River, Goshen Pass, 1225′ (*n*=22); U780 Bratton Creek, 2 mi. SW of Goshen, 1410′ (*n*=22); U779 Bratton Creek, 4.3 mi. SW of Goshen, 1500′ (*n*=14); U515 North Mountain, 6.0 mi. W. of Collierstown, 2680′ (*n*=28); U514 North Mountain, E. side, 5.1 mi. W. of Collierstown, 2320′ (*n*=28). BATH COUNTY: U330 Mill Creek, Panther Gap, 3 mi. W. of Goshen, 1560′ (*n*=22); U559 Cowpasture River, ½ mi. E. of Fort Lewis, 6½ mi. S. of Williamsville, 1540′ (*n*=22); U775 Dry Run, 7 mi. NW of Millboro Springs, 1480′ (*n*=22); U772 Blackie's Hollow, 4 mi. directly N. of Millboro Springs, 1460′ (*n*=22); U774 Cowpasture River, 0.2 mi. W. of U772, 1380′ (*n*=22); U777 Thompson Creek, 4.7 mi. NW of Millboro Springs, 1410′ (*n*=22); U472 Cowpasture River, S. edge of Millboro Springs, 1350′ (*n*=14); U328 Cowpasture River, 10 mi. NE of Clifton Forge, 1175′ (*n*=14); U471 Cowpasture River, 9 mi. NE of Clifton Forge, 1150′ (*n*=14); U518 Mill Creek, 7.9 mi. N. of dam at Douthat Lake, 1450′ (*n*=14); U517 Wilson Creek, below dam at Douthat State Park, 1420′ (*n*=22); U519 E. of summit of Warm Springs Mt., 1.8 mi. E. of Warm Springs, 2875′ (*n*=22); *R. T. Clausen* 6991 West of Warm Springs (*n*=22); U520, U586 Back Creek, 1.5 mi. S. of Mountain Grove, 1750′ (*n*=22); U521 Little Back Creek, 3.3 mi. NW of Mountain Grove, 1860′ (*n*=22); U587 N. entrance of Richardson Gorge, Jackson River, 6.8 mi. W. of Warm Springs, 1680′ (*n*=22); U588 SE end Richardson Gorge, Jackson River, opposite junction of Back Creek, 1700′ (*n*=22); U589 Jackson River, 3.5 mi. S. of junction of Back Creek, 1560′ (*n*=22); U585 Bolar Draft, 7½ mi. S. of Mountain Grove, 1640′ (*n*=22); U584 Jackson River, 2.6 mi. N. of Alleghany County line, 1530′ (*n*=22). ALLEGHANY COUNTY: U470 Cowpasture River, 6 mi. NE of Clifton Forge, 1160′ (*n*=28); U326, U423 Cowpasture River, 5½ mi. NE of Clifton Forge, 1150′ (*n*=28); U516 Wilson Creek, 4½ mi. N. of Clifton Forge, 1200′ (*n*=22); U422 Johnson Mt., 4 mi. S. of Lowmoor, 1875′ (*n*=22); U268 Road cut, US220, 8 mi. NNE of Covington, 2250′ (*n*=22, *n*=44); U583 Jackson River, at W. end of The Gorge, 1 mi. S. of Bath County line, 1500′ (*n*=22); U591 Jackson River, 0.2 mi. S. of Indian Draft, 6 mi. N. of Covington, 1350′ (*n*=22); U597 Blue Spring Creek, 7 mi. directly S.

of Covington, 1750′ (*n*=22); U325 Dunlap Creek, 3 mi. W. of Covington, 1325′ (*n*=22); U581 Cove Run, 1.6 mi. N. of Callaghan, 1520′ (*n*=22); U592 Potts Creek, 3.6 mi. S. of Covington, 1230′ (*n*=22); U593 Potts Creek, 7.3 mi. SW of Covington, 1300′ (*n*=22); U595 Potts Creek, 10.9 mi. SW of Covington, 1350′ (*n*=22); U596 Potts Creek, 16.7 mi. SW of Covington, 3.4 mi. SW of Jordan Mines, 1600′ (*n*=14); U324 3 mi. NE of Crows, 1575′ (*n*=22). BOTETOURT COUNTY: U469 James River, 2 mi. S. of Iron Gate, 1000′ (*n*=22); U421, U598 Richpatch Mountain, 7 mi. S. of Lowmoor, 1800′ (*n*=22); U599 Craig Creek, 2.3 mi. NW of Eagle Rock, 950′ (*n*=22); U510 Renick Run, 7 mi. N. of Buchanan, 1570′ (*n*=14); U508, U601 0.7 mi. NW of Indian Rock, 1000′ (*n*=22); U420 Craig Creek, 2 mi. SW of Oriskany, 1175′ (*n*=14); U600, *R. T. Clausen* and *C. H. Uhl* 6795 Catawba Creek, 1.4 mi. N. of Fincastle, 1050′ (*n*=14); U1585 Pine Tree Overlook, Mile 95.3, Blue Ridge Parkway, 2524′ (*n*=14). BEDFORD COUNTY: *R. T. Clausen & Uhl* 6785 Spring in notch between Peaks of Otter, 2360′ (*n*=14); *R. T. Clausen & Uhl* 6792 South Peak of Otter, elev. ca. 3100′ (*n*=14); *R. T. Clausen & Uhl* 6789 South Peak of Otter, elev. ca. 3400′ (*n*=14). CRAIG COUNTY: U322 Potts Mountain summit, 5 mi. SE of Paint Bank, 3450′ (*n*=14); U321 Meadow Creek, 2.4 mi. SW of Newcastle, 2100′ (*n*=14). GILES COUNTY: U429 Sinking Creek, Mouth of Tauney's Cave, 1½ mi. NE of Maybrook, *(D. W. Bierhorst)* (*n*=14); Mountain Lake (*J. T. Baldwin*, 1942) (*n*=14); U320 New River, 1½ mi. N. of Ripplemead, 1700′ (*n*=14); U636 New River, 0.5 mi. S. of Ripplemead (*n*=14); U430 New River, 0.7 mi. S. of Ripplemead, 1875′ *(D. W. Bierhorst)* (*n*=14). ROANOKE COUNTY: Roanoke, (*J. T. Baldwin*, 1942) (*n*=14). MONTGOMERY COUNTY: U1120 Roanoke River, W. of Elliston (*n*=14); U463 Little River, ½ mi. S. of Claytor L. dam, 1775′ (*n*=14). PULASKI COUNTY: U465 New River, at Claytor L. dam (*n*=14). FRANKLIN COUNTY: U1668 Maggodee Creek, N. of Boones Mill, 1050′ (*n*=14). FLOYD COUNTY: U462 Little Camp Creek, 10 mi. NW of Floyd (*n*=14); U461 Rocky Knob Park campground, Mile 169, Blue Ridge Parkway, 2250′ (*n*=14). MECKLENBURG COUNTY: *R. T. Clausen & Uhl* 6801 Goodes Ferry, Roanoke River, US1, S. of South Hill, 200′ (*n*=14).

North Carolina. ROCKINGHAM COUNTY: *R. T. Clausen* 6763 Smith River, near Spray (Eden), 650′ (*n*=14).

SOME ABERRANT PYROLA COLLECTIONS FROM EASTERN NORTH AMERICA

ERICH HABER

The occurrence of aberrant specimens in the genus *Pyrola* is nothing new. Indeed, abnormalities of various kinds can usually be found in any species if a sufficient number of specimens are examined. In several instances, however, the aberrant nature of the *Pyrola* specimens was not recognized, and the plants were subsequently described as new species.

Pyrola compacta, collected by Otto E. and Grace K. Jennings in 1912 and described by him (1920) as a new species, is a clone of such aberrant specimens. In all their basic features, the type specimens (fig. 1) represent abnormal plants of *P. elliptica* Nutt. growing in a somewhat unusual habitat, namely, in a wet, open pasture. The latter species is more characteristically found in somewhat dry to dampish situations in mixed hardwoods. The features which indicate most clearly the similarity of the type specimens with *P. elliptica* are the elliptic, oval to obovate leaves and the short triangular-lanceolate sepals with acuminate apices and overlapping bases. Although the sepals are five in number, it is the abnormally large number of petals which give the inflorescences their dense, "compact" appearance. This is due to the fact that some of the stamens in each flower have become completely petaloid, thereby increasing the petal number from 5 to 8 or possibly more.

In some instances, the stamens, although quite petaloid, have partly developed anther sacs projecting from the surface. The anthers of the remaining stamens which appear to be nearly normal have very conspicuous, generally fimbriate mucros which in some cases tend to be slightly petaloid as well. The shape of the anther tubes are also like those found in *P. elliptica*. Jennings noted in his description of the type specimens that they resembled *P. elliptica* very closely. Based on the dried specimens, he concluded

Fig. 1. Type specimens of *Pyrola compacta* illustrating the general habit and leaf shape of *P. elliptica* (A) and the abnormal flowers with extra petals and conspicuously mucronate anthers (B).

Fig. 2. Type specimen of *Pyrola oxypetala* (A & B) and an abnormal specimen of *P. asarifolia* var. *asarifolia* (C & D). The two mutant specimens are similar in their erect flowers and extrose stamens.

that the flower color must have been purplish or rose. It is more likely that the flowers were white as in typical *P. elliptica* since all of the specimens on the sheet are scorched to a deep brown color. The appearance of these petals is much like those on similar sheets of *P. elliptica*. Jennings also reported that the type specimens were very fragrant; a similar observation has also been made for *P. elliptica* by Lakela (1965). *P. compacta* appears to have been overlooked in the literature, for no mention of the name has been found applied either to a distinct species or in synonymy with *P. elliptica*.

Pyrola oxypetala Austin, maintained as a distinct species in the eighth edition of Gray's Manual, is more appropriately placed in synonymy with *P. virens* Schweigg as has been done by Gleason (1963). The type specimen (fig. 2, A & B) collected near Deposit, N.Y. exhibits the ovate leaves of *P. virens*, although somewhat more lanceolate than normal, as well as the short, merely acute, triangular-ovate sepal lobes which do not overlap at the bases. The flowers are abnormal in that they are held erect and that the petals taper either gradually or quite abruptly to a sharp point; as well, the stamens are extrose with the tubes facing the base of the ovary rather than being inverted (with the tubes pointing away from the ovary) as in normal *Pyrola* flowers during anthesis. The stamens in *Pyrola* buds are always extrose but become introse by the time the flowers are fully opened. The short, barely exserted, straight style of *P. oxypetala* with the stigmatic lobes not yet visible at the tip also appears as in many young *Pyrola* flowers.

The erect flowers, extrose stamens, and short, straight style are not features unique to this plant alone. One specimen of *P. asarifolia* from the Thunder Bay District of Ontario (LKHD 9257; fig. 2, C & D), typical in all key features such as the ovate-cordate leaves, the shape and length of the sepals, and the pink flowers, exhibits these same features. The inflorescence with its flowers borne on long, erect pedicels has the appearance of an ornate candelabrum. Although the flowers were apparently almost

fully open when the plant was collected, the stamens are still completely extrose and the short style barely exserted.

The morphological changes brought on by mutations are not always quite so conspicuous; mutations producing minor changes are more frequently found. One collection of *P. asarifolia* (CAN 86307) was found in which the sepals in each flower were fused into two groups — one with 3 sepals, the other with 2. Variations in the numbers of floral parts may sometimes be found as in *P. asarifolia* (CAN 237255) in which one flower on the plant had its sepals, petals, carpels, and stigmas in 6's and as well had 12 stamens. Somewhat similar variations in the number of floral parts have also been observed in specimens of *P. minor* and *P. grandiflora*.

Without a doubt mutations play their role in the process of speciation through the introduction of additional variation. However, such gross alterations of the basic floral structures of individual plants or clones from the population norm as seen in *P. compacta* and *P. oxypetala* must surely offer little adaptive advantage to the plants. The monstrous origin of such aberrations should be noted, but such individuals deserve no specific recognition.

Specimens Cited

Pyrola compacta Jennings (Type): Wet, open pasture near Sixmile Lake (Louise Lake), Thunder Cape, northwestern Ontario, Aug. 20, 1912, *Otto E. & Grace K. Jennings* (CM). *Pyrola oxypetala* Austin (Type): Wooded hill near Deposit, Delaware Co., N.Y., June 1, 1860, *C. F. Austin* (GH). *Pyrola asarifolia* Michx. var. *asarifolia*: Rocky woods along lakeshore, north shore of Little Pigeon Bay, Crooks Tp., Thunder Bay District, Ontario, July 8, 1952, *C. E. Garton* 1785 (LKHD 9257). *Pyrola asarifolia* Michx. var. *purpurea* (Bunge) Fern.: Near Mud Lake, Oliver Tp., Thunder Bay District, Ontario, June 30, 1937, *C. E. Garton* 511 (CAN 86307); Larch bog, vicinity of Knob Lake, north of John Lake, Quebec, 54°48′ N., 66°49′ W., July 11, 1955, *L. A. Viereck* 618 (CAN 237255).

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DEPARTMENT OF BOTANY
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JUNCUS SLWOOKOöRUM, A NEW SPECIES FROM ARCTIC ALASKA

STEVEN B. YOUNG

On July 23, 1966, I collected specimens of a small *Juncus* near Boxer Bay (63° 22′ N. Lat., 171° 35′ W. Long.) southwestern Saint Lawrence Island, in the northern Bering Sea. These specimens cannot be identified as any known species of Juncus. They show some similarity to depauperate specimens of *J. Fauriensis* Buch., an East Asian species not known to occur in Alaska. However, the equitant leaves and unique, two flowered inflorescences (Fig. 1) of the new species are distinctive. Each of the approximately 10 inflorescences examined were identical in that they consisted of two flowers. The lower flower is essentially sessile; the upper is borne on a pedicel about 5 mm long. Each of the flowers probably represents a reduced head.

The specimens were collected at the edge of a small tundra pond. They grew in thick, saturated moss, in association with *Saxifraga nudicaulis* D. Don. and *S. rivularis* L.

The new species is named after the Slwooko family of Gambell, Saint Lawrence Island. Several members of this family contributed greatly to the success of my field work on the island. Boxer Bay, the type locality for *J. Slwookoörum*, is the ancestral hunting and trapping ground of the Slwookos.

Juncus Slwookoörum S. B. Young

Perennis, rhizomate brevi horizontali, radicibus filiformibus elongatibus. *Caulis erectus*, 5-15 cm altus, teres. *Folia* basalaria 10-15 cm alta, *equitantia*. *Vagina* in auriculis duabus obtusis castaneis producta. *Lamina* foliosa, septis transversis completis externe plus minusve prominentibus interceptis. *Inflorescentia* terminalis, *2-florae*, superata bractea foliacea longa. *Flos inferior sessilis*; *flos superior portatus in pedicello* plus minusve 5 mm longo. *Flores* 4-5 mm longi. *Tepala* membranacea, castanea, uninervia, lanceolata, acuta, aequilonga vel externa paullo longiora.

Fig. 1. *Juncas Slwookoörum:* A — typical habit, B — typical inflorescence, consisting of two flowers, one sessile, the other borne on a pedicel.

Stamina tres, perigonium superantia. *Stylus* filiformis; stigmata 3, longa, exserta, torta. *Fructus* c 2 mm longus, obovatus, non rostratus; pericarpium membranaceum, pallidum. Holotypus: *S. B. Young 711* (GH): Sinus Boxeri, Insula Sancti Laurentii. Perennial with short horizontal rhizome and elongated filiform roots. *Stem* erect, 5-15 cm tall, terete (or slightly flattened in dried specimens). *Basal leaves* 10-15 cm long, *equitant*. *Sheath* extended in two obtuse, castaneous auriculi. *Blade* flat and foliaceous, at least the upper portions having more or less prominent transverse septa. *Inflorescence* terminal, *2-flowered*, overtopped by a long leafy bract. *Lower flower sessile*, the *upper flower borne on a pedicel* c 5 cm long. *Flowers* 4-5 mm long. *Tepals* membranaceous, brown, 1-nerved, lanceolate, acute, of equal length or the exterior ones slightly longer. *Stamens* 3, overtopping the perigon. *Style* filiform, stigmas 3, long, exserted, and twisted. Fruit c 2 mm long, obovate, beakless; pericarp membranaceous, pale.

Juncus Slwookoörum joins a small but fairly distinctive group of species whose ranges are narrowly endemic to the Bering Straits region. Other examples are *Carex Jacobipeteri* Hult., *Papaver Walpolei* Pors., *Saxifraga nudicaulis* D. Don. (with disjunct stations in eastern Asia), and *Artemisia senjavenensis* Bess. These species probably represent remnants of a specialized flora of the northern portion of the Bering Land Bridge.

Field work on Saint Lawrence Island was supported by grants from the Institute of Evolutionary Biology of Harvard University, the Fernald Fund of the Gray Herbarium, and Sigma Xi.

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THE SOUTHERN LIMITS OF TRIENTALIS BOREALIS

WILBUR H. DUNCAN

Trientalis borealis Raf. is now known to be another of those species having northern affinities but extending southward in the mountains of the eastern United States into Georgia. On the basis of known stations this species is in one sense doubly disjunct. There are a number of localities where the species is known to occur in the mountains as far south as southern West Virginia and adjacent Virginia, in the Kanawha Plateau, Allegheny Mountains, and Ridge and Valley Province. Southward there are only two widely separated localities known for the species. The next station south of those in Virginia and West Virginia was reported by James (1955) from northeastern Tennessee in the hills of Sullivan County near Bristol. This locality is about 90 miles from the nearest known population to the north, that in Mercer County, West Virginia. Sharp and Baker (1964) state that in Tennessee *T. borealis* "has been collected only in Sullivan County."

On 12 May 1963 I collected *Trientalis borealis* at about 3,700 feet elevation in a north-facing ravine in the southern part of Union County, Georgia. This locality is about 160 miles from the nearest known station, in Tennessee. It is on the basis of the 90 mile and 160 mile intervals that I suggest the species might be described as doubly disjunct in the southeastern mountains.

That the station in Georgia represents a significant extension in range was established by analyzing distributional data from the University of Georgia and other herbaria.[1] These data are recorded on Map 1. The westernmost records shown in Minnesota and the southernmost records in the states from Illinois to Georgia and Delaware are at or near the known western and southern limits of the species in the United States. However, since I sought primarily to

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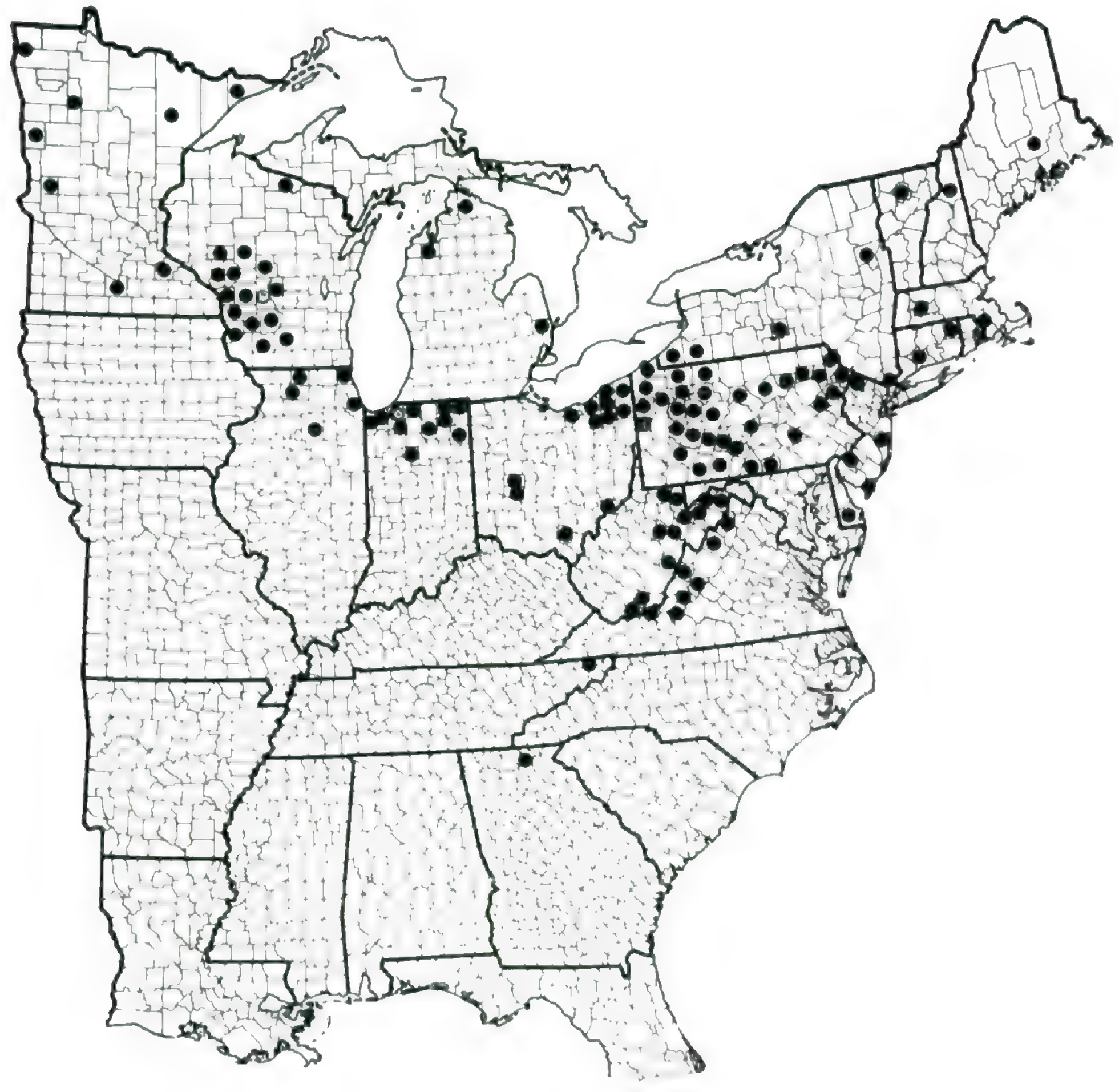
[1]The records generously provided by curators from the several herbaria are gratefully acknowledged.



Map 1. Southern distribution of *Trientalis borealis*.

establish the southern limits of *T. borealis*, the records shown northward on Map 1 do not reflect its abundance there. Distributional data given by Anderson (1968) show that the species is more abundant northward, although failing to show the southernmost records for Illinois and Ohio and the single record previously reported for northeastern Tennessee. The species has also been reported in Canada west to Alberta and northeast to Labrador (Gleason and Cronquist, 1963; Anderson, 1968).

Much botanizing has been done in the Smoky Mountains and other parts of the southern mountains without *Trientalis* being found, therefore making the "outpost" in Georgia of considerable interest. The factors which provide a suit-

able habitat at the Georgia station, and which are apparently not present at intervening habitats, are not known. The ravine, however, is obviously cool in nature and is occupied mostly by species which are distinctly northern in distribution.

The ravine drops from about 4,000 to 3,150 feet elevation in 0.35 mile between two ridges which run downwardly N 26° W and N 30° E respectively from a point where they diverge from a single higher ridge. Little sun reaches the forest floor in the heart of the ravine. Early and late in the day the two ridges block out the sun. In the middle part of the day the sun is too low on the horizon to shine on the floor except in summer and then the rays are at such a steep angle with the floor of the ravine that the canopy of the woody vegetation provides a considerable barrier to them.

Much of the ravine is occupied by small to very large angular boulders in a jumbled arrangement. Some of the thousands of plants of *Trientalis* growing in the ravine occur on top of boulders; others occur between the boulders and on parts of the steep slopes of the eastern side of the ravine. When plants from different localities in the ravine were dug up it was discovered that all were rooted in weakly consolidated, partially decayed light brown humus composed largely of leaves from deciduous woody plants. The roots seemed to have little association with the mineral soil. Anderson (1968) reports that the rhizome grows just under the organic layer to within a centimeter of the surface in Wisconsin.

Vegetation in the ravine is quite northern in aspect, most of the species occurring there being typically northern in their distribution. For example, *Dryopteris goldiana* (Hook.) A. Gray was reported from there as the southernmost record for the species (Duncan, 1948). The character of the vegetation in the ravine is indicated by the following list of some other species occurring there.

WOODY PLANTS: *Juglans cinerea, Betula lenta, B. lutea, Magnolia acuminata, M. fraseri, Rubus odoratus,*

Cladrastis lutea, *Ilex montana*, *Euonymous obovatus*, *Acer pennsylvanicum*, *A. spicatum*, and *Aesculus octandra*. HERBACEOUS PLANTS: *Trillium erectum*, *T. grandiflorum*, *T. vaseyi*, *Asarum canadense*, *Aquilegia canadensis*, *Diphylleia cymosa*, *Dicentra canadensis*, *D. cucullaria*, *Impatiens pallida*, *Aralia nudicaulis*, *Hydrophyllum canadense*, and *Monarda didyma*.

I overlooked *Trientalis* on previous visits to the ravine, and others may have overlooked the species elsewhere in the southeastern United States. Mature plants of *Trientalis* with their single whorls of leaves resemble *Medeola virginiana* and some species of *Lysimachia*. A second and careful look at plants of that appearance may reward the observer with the discovery of a third station for *Trientalis borealis* in the southeastern United States.

A voucher specimen of *Trientalis borealis* from Georgia is on deposit in the University of Georgia Herbarium (*Duncan* 22050).

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FURTHER ADDITIONS TO THE BRYOFLORA OF MT. KATAHDIN, MAINE

F. J. Hermann

On August 19, 1963 I had an opportunity to make the ascent of Mt. Katahdin via the Abol Trail, returning by way of the Appalachian Trail, and as a result of this and an earlier partial climb as far as Chimney Pond was able to report the addition of 20 mosses and 2 hepatics to the 86 bryophytes previously known from the mountain (77 reported by Kennedy and Collins, 5 by Lorentz and 4 by Lowe). The following year a second ascent, on August 28, via the Appalachian and Saddle Trails, and a hike up South Turner Mt. (essentially a spur of Katahdin) on September 1, resulted in the further addition of 21 unrecorded bryophytes (14 Musci and 7 Hepatics) which are here recorded to bring the total now known from Mt. Katahdin up to 129. As with the previous year's collections, a set has been deposited in the U. S. National Herbarium and duplicates of most have been distributed to several other major herbaria. To avoid repetition of habitat data the species are listed according to collecting sites.

Tundra on plateau, Baxter Peak Cutoff, 4600 ft.:
Dicranum muehlenbeckii BSG., 19594.
Cephalozia ambigua Massal., 19594½. Although Frye and Clark recorded this species from only "Ellesmere Isl.; Pim Island; Southern Applachian Mts., Europe," it is probably more widely distributed than supposed, very likely being generally overlooked because of its minute size. It was found to be plentiful, for instance, at the edge of melting snowbanks on Mt. Baker, Washington.

Vertical face of granite boulder, Saddle Trail, 3500 ft.:
Ptilidium pulcherrimum (Web.) Hampe, 19601½.

Humus on granite ledge above Katahdin Falls, 1700 ft.:
Sharpiella striatella (Brid.) Iwats., 19571.
Plagiothecium denticulatum (Hedw.) BSG., 19573.

Wet, shaded bank of Katahdin Stream below Falls:
Calypogeia meylanii Buch, 19568.
Cephalozia bicuspidata (L.) Dumort., 19570.
Pellia fabroniana Raddi, 19567.

Vertical face of granite boulder in woods, Appalachian Trail, 3000 ft.:
Trichostomum tenuirostre (Brid.) E. G. Britt., 19581.

Boggy swale in Thuja-Betula woods on SE shore of Sandy Stream Pond, 1500 ft.:
Calliergon stramineum (Brid.) Kindb., 19621.
Dicranodontium denundatum (Brid.) E. G. Britt., 19623. An unusually wet habitat for this species.
Drepanocladus exannulatus (BSG.) Warnst., 19618.
Rhizomnium pseudopunctatum (Bruch & Schimp.) Kopon., 19620.
Chiloscyphus pallescens (Ehrh.) Dumort., 19619½.
Pellia epiphylla (L.) Corda, 19619.

Gravelly trail through open woods, South Turner Mt.:
Brachythecium starkei (Brid.) B. & G., 1600 ft., 19624.
Bryum pallens (Web. & Mohr) Brid., 2200 ft., 19632.
Hypnum haldanianum Grev. (*Heterophyllum haldaneanum* (Grev.) Kindb.), 2600 ft., 196331½.

In pool along trail, South Turner Mt., 1600 ft.:
Dichelyma falcatum (Hedw.) Myr., 19624.
Drepanocladus fluitans (Hedw.) Warnst., 19625.

Granite boulder along trail, South Turner Mt., 1800 ft.:
Rhacomitrium heterostichum var. **affine** (Schleich.) C. Jens., 19627.

FOREST SERVICE HERBARIUM
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

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CONTRIBUTIONS TO THE FLORA OF WASHINGTON

GEORGE W. DOUGLAS[1] and RONALD J. TAYLOR

The flora of Washington is generally rather well known and has received considerable attention over the years, particularly with the completion of the comprehensive treatment, Vascular Plants of the Pacific Northwest, Volumes 1-5 (Hitchcock, *et al.*, 1955, 1959, 1961, 1964, 1969). However, floristic studies in the northwestern corner of the state have been relatively incomplete. This is particularly true of the Cascades north of Stevens Pass where the rugged mountain wilderness remains very inaccessible. Recent collections by the authors have provided a more complete botanical coverage of the North Cascades; and in this paper, eight new records of vascular plants and mosses are reported for Washington together with a number of significant geographical and altitudinal range extensions. Most representatives were collected in subalpine or alpine habitats, a few are lowland species.

The specimens cited are deposited in one or more of the following herbaria: G. W. Douglas (private) (GD); New York Botanical Garden (NY); Skagit Valley Community College (SV); U. S. Forest Service (FS); University of Washington (UW); and Western Washington State College (WW). Nomenclatural determinations were made by the authors unless otherwise noted. New species records are designated by an asterisk.

VASCULAR PLANTS

Polystichum munitum (Kaulf.) Presl. var. **munitum**. Green Mountain, Snohomish Co., *Douglas* 870 (GD); Sourdough Ridge, Whatcom Co., *Douglas* 1900 (GD). This species is usually found from low to middle elevations (sea level to

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ca. 900 m) in the moist continuous forests of the region. The Green Mountain collection was taken at 1555 m elevation on a steep colluvial slope beneath an isolated tree (*Tsuga heterophylla* (Raf.) Sarg.) in the Subalpine Zone. The Sourdough Ridge collection was established beneath krummholz (*Abies lasiocarpa* (Hook.) Nutt.) at an elevation of 1920 m in the Alpine Zone. The Green Mountain collection was typical of the species while the Sourdough Ridge collection was depauperate and reached a height of only 15 cm. Both specimens had well developed sporangia.

Pteridium aquilinum (L.) Kuhn ssp. **aquilinum** var. **pubescens** Underw. Green Mountain, Snohomish Co., *Douglas & Pearson* 1632 (GD). A common species at lower elevations throughout Washington. The Green Mountain specimen was collected on deep well-drained soil of a steep colluvial slope at 1610 m elevation. This fern is an important component of the lush herbaceous associations found on steep colluvial slopes or avalanche tracks throughout the Subalpine Zone (Douglas, 1970).

Carex multicostata MacKenzie. Elephant Butte, Whatcom Co., *Douglas* 1735 (GD, FS). This collection was made on an exposed alpine ridge at 1920 m elevation. The previous known range of this species was the Cascade-Sierran region from central Washington south to the mountains of southern California, and in the mountains of eastern Oregon and adjacent Idaho (Hitchcock, *et al.*, 1969). The identification was made by Dr. F. J. Hermann.

Carex straminiformis Bailey. Green Mountain, Snohomish Co., *Douglas* 421, 431, 460, 551 (GD, FS). A frequent plant on mesic subalpine sites of the Green Mountain area. This species was known previously from the Sierra Nevada of California and adjacent Nevada extending north irregularly into the Cascade region to Mt. Adams in southern Washington, and disjunct in the Wasatch Mountains of Utah and the mountains of central Idaho (Hitchcock *et al.*, 1969). These specimens were identified by Dr. F. J. Hermann.

*__Carex subfusca__ W. Boott. Stehekin River, Chelan Co., *Douglas* and *Lowery* 1217 (GD, FS, UW). This collection, a new record for the state, was taken from a population of several scattered specimens established on a dry gravel floodplain. The species was previously known from the Klamath region of northwestern California and southwestern Oregon to the Sierra Nevadas and the mountains of southern California, extending east to the mountains of Arizona and southwest Utah and north into the Cascades to Mt. Hood in northern Oregon (Hitchcock, *et al.*, 1969). The specimen was identified by Dr. F. J. Hermann.

*__Poa rupicola__ Nash. Chowder Ridge, Whatcom Co., *Taylor* 762, 763 (WW). These two collections were taken at 2120 m elevation from a dry interrupted alpine meadow dominated by *Carex phaeocephala* Piper. This is the first record of this grass in Washington. Hitchcock, *et al.*, (1969) report the species is distributed from the Yukon, British Columbia and Alberta southward through the Rocky Mountains to Utah, Colorado and New Mexico, east to South Dakota, west to northeast Oregon, Nevada, the Sierra Nevadas of California, and northern Arizona.

*__Salix myrtillifolia__ Anderss. Miners Ridge, Snohomish Co., *Naas & Naas* (SV). This collection, a new record for the state, was taken from an alpine ridge at 1920 m elevation. Its previous range extended from Newfoundland and Quebec to Alaska and British Columbia (east of the continental divide), south to California, southern Utah, Wyoming, and possibly northern Colorado (Hitchcock, *et al.*, 1964). The specimen was identified by Dr. C. L. Hitchcock.

__Salix vestita__ Pursh var. __erecta__ Anderss. Twin Lakes, Whatcom Co., Douglas 1950 (NY). This low shrub occurred on a wet, north facing subalpine scree slope at 1585 m elevation. It is an atypical specimen with style and stigmas too long, leaves too soon glabrous and bracts of the aments too green. The specimen is probably a hybrid between *S. vestita* var. *erecta* and possibly *S. phylicifolia* L. var. *pennata* (Ball)

Cronq. (A. Cronquist, personal communication). This species was previously known in the Rocky Mountain region from southern Alberta and adjacent British Columbia to west central Montana, the Wallowa Mountains of Oregon, and in Chelan Co., Washington (Hitchcock, *et al.*, 1964). The specimen was determined by Dr. A. Cronquist.

***Ranunculus ficaria** L. Marietta, Whatcom Co., *Taylor* 2313, *Sundquist* 1114, 1165, 1550 (WW). These collections were all taken from a single population which forms a dense mat along the margin of a playground, previously a marsh. According to Dr. Lyman Benson who confirmed the identification, this is the first recorded collection from the Pacific Northwest in the United States although a previous collection was made in British Columbia. The species is native to Europe and sparingly introduced in North America (Fernald, 1950).

Impatiens capensis Meerb. Lake Whatcom, Whatcom Co. *Sundquist* 1865, 1414, 1432, others (WW). This species is well established along the moist banks of Lake Whatcom. Its occurrence in the Pacific Northwest has been previously noted by Ornduff (1966).

***Gentiana glauca** Pall. Skyline Ridge, Whatcom Co., *Taylor* 1232 (WW); Skyline Ridge, Whatcom Co., *Hobbs* 12 (WW). These collections were taken at 1900 m elevation from an alpine meadow dominated by *Carex* spp. and disrupted by frost heaving. A new record for the state, this species was previously known from Alaska and Yukon extending south to British Columbia and in the Rocky Mountains to Montana. It is also known in Asia (Hitchcock, *et al.*, 1959). Mt. Garibaldi, in the southern British Columbia Coast Range, is apparently the southernmost station in British Columbia (Henry, 1915).

Castilleja parviflora Bong. var. **oreopola** (Greenm.) Ownbey. Yellow Aster Butte, Whatcom Co., *Douglas* 1527 (GD, NY). This collection was taken in a moist subalpine meadow at 1585 m elevation. It represents a substantial range exten-

sion, known previously from the Three Sisters Peak in Oregon to Mt. Rainier in Washington (Hitchcock, *et al.*, 1959). The specimen was identified by Dr. N. H. Holmgren.

***Centaurea montana** L. Newhalem, Skagit Co., *Naas & Naas* (SV). The specimen was established with other members of the species in open fields of the area. This species, native to Europe (Hegi, 1954), has not previously been reported outside of cultivation in western North America.

MOSSES

***Pogonatum alpinum** (Hedw.) Rohl var. **septentrionale** (Brid.) Brid. Green Mountain, Snohomish Co., *Douglas* 695 (GD). This collection was taken on a flat, poorly drained site in the Subalpine Zone dominated by a thick mat of *Carex nigricans* C. A. Mey. A new record for Washington, this moss was previously known from Greenland and Alaska, British Columbia and Colorado, as well as Europe and Asia (Grout, 1936). The specimen was identified by Dr. E. Lawton.

***Bryum cyclophyllum** (Schwaegr.) B. S. G. Winchester Mountain, Whatcom Co., *Douglas* 734 (GD, UW). The specimen was established in a moist rock crevice at 1585 m elevation. This moss, a new record for the state, is known from Greenland and arctic America extending south to New Jersey, Pennsylvania and Wisconsin, west to British Columbia, and also occurring in Europe and Asia (Grout, 1933). The specimen was identified by Dr. E. Lawton.

Pohlia cardotii (Ren.) Broth. Seward Peak, Whatcom Co., *Douglas* 841 (GD, UW). This collection was taken in a poorly drained southeast basin in the Subalpine Zone. *Carex nigricans* was the sole dominant on the site. Very few collections of this species have been made and it was previously known only from Mt. Hood and Mt. Rainier (Grout, 1933). The specimen was identified by Dr. E. Lawton.

Lescuraea saviana (De Not.) Lawt. Green Mountain, Snohomish Co., *Douglas* 642 (GD, UW). This species occurs in

moist subalpine meadows of the area. It is a common moss in Europe but is rare in North America (Lawton, 1957) where the only previous collections were made in the Olympic Mountains and on Mt. Rainier. The specimen was identified by Dr. E. Lawton.

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MONARDA STIPITATOGLANDULOSA, A NEW SPECIES FROM OKLAHOMA

U. T. Waterfall

While collecting in southeastern Oklahoma in late June, 1966, the author noted a rather dwarf, erect, colonial member of the Labiateae on a mountain top, or ridge top, in Beaver Bend State Park, north of Broken Bow in McCurtain County. It was past anthesis, and appeared to be either a *Monarda*, or a *Pycnanthemum*. He had seen it before, but not in flowering condition, so he dug it up and transplanted it at his home in Stillwater.

In the spring of 1970, after having spread by rhizomes, the colony flowered abundantly. The material seemed different enough from its nearest relative, *Monarda fistulosa* var. *mollis*, or from any other taxa in the genus as described by McClintock and Epling (1942), to warrant its description.

Its principal differentiating characteristics are: (1) its stipitate-glandular calyx teeth, the glands large, capitate, on stipes of varying length; in *Monarda fistulosa* var. *mollis* the calyx teeth vary from eglandular to sessile-glandular; (2) it has minute stipitate-glandular hairs on the external surface of the calyx tube; in *M. fistulosa* var. *mollis* the calyx tube varies from nearly glabrous to abundantly vestite with small, spreading or curled hairs, sometimes with sessile glands intermixed; (3) the vestiture of the bracts may also include short, stipitate-glandular hairs, as well as long multicellular hairs; (4) the orifice of the calyx tube has horizontal, inwardly directed stiff hairs, or inwardly ascending hairs, not long enough to close the orifice in post-anthesis calyces; in *M. fistulosa* var. *mollis* the abundant stiff hairs are erect to strongly incurved-ascending, and there is often an outer, outwardly reflexed circle of hairs; (5) the corolla is white; in our *M. fistulosa* var. *mollis* it is lavender, sometimes a lighter color.

The lower lip of the corolla is down-curved, with an abrupt, upward-turned apical tip 3-4 mm long; the style extends 2-3 mm beyond the tip of the upper lip; the fruit is oblong-ovate to oblong, 1.3-1.8 mm long, light brown in color.

The original collection, from shallow, stony soil, was of rather dwarf plants, as compared with *M. fistulosa* var. *mollis*, the plants being 20-25 cm tall. The garden-raised ones were 30-40 cm tall, growing larger under better conditions, but still much shorter than *M. fistulosa* var. *mollis* native in the same area. The plants began to flower May 18th, about 3-4 weeks before *M. fistulosa* var. *mollis* begins to flower in the same vicinity.

M. stipitatoglandulosa Waterfall, *sp. nov.* Planta erecta, rhizomotosa, nana, 20-40 cm alta; caulibus minute curvipilis; foliis lanceolatis, vel angustolanceolatis, paucidentatis; petiolis 2-15 mm longis; bracteis stipitatoglandulosis et trichomatibus longis; calycibus tubularibus minute stipitatoglandulosis; corollis plus minusve falcatis, albis, 25-30 mm longis; labellis infernis ca 12-15 mm longis; labellis supernis 12-14 mm longis; stylis exsertis 2-3 mm; fructibus oblongis-ovatis vel oblongis, 1.3-1.8 mm longis, pallide brunneis.

Holotypus: *Waterfall* 17478, raised in garden from plants collected in an opening on a wooded mountain top, 7 miles north and 2.7 east of Broken Bow, McCurtain County, May 22, 1970 (OKLA). Isotypes will be distributed.

A second collection referred to *M. stipitatoglandulosa* is *Harry Love* 159; rocky, oak-covered hillside, 1 mile south of Cloudy, Pushmataha County, June 19, 1966 (OKLA).

The finding of this species in McCurtain and Pushmataha counties is reminiscent of two other similarly endemic species, *Streptanthus squamiformis* Goodman (1956), also described from Beaver Bend State Park, and the unique *Carex latebracteata* Waterfall (1954), described from a few miles north of the park, but also found in the park, and later discovered in adjacent LeFlore County (Means, 1969).

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THE FLORA OF ISLE AU HAUT, MAINE[1]

DAVID A. WISE

Isle au Haut, in the outermost part of Penobscot Bay, Maine, covers an area of over seven square miles, or 4700 acres, 2800 of which are in Acadia National Park. Though first discovered by Champlain in 1604, who originally named it "Isle Haute", the island was not permanently settled until 1792. By 1864 the population had risen to around 300 settlers, most of whom engaged in fishing and small scale farming. Today the island's population is seasonal, rising to a few hundred during the summer months, with only twenty or thirty permanent residents remaining through the winter.

The general topographic aspect of the island is dominated by a central north-south ridge of hills. Of these the most prominent is Champlain Mountain (543 feet). Bogs are frequent in lowland areas with none of any consequence occurring above 200 feet. The interior of the island is drained by a number of small seasonal streams, and one relatively large body of freshwater, Long Pond, is located at the southeastern end of the island.

The Isle au Haut shoreline is typical of much of the "drowned coast" of the Penobscot Bay region. For the most part it is highly irregular, rocky, and steep with pronounced headlands present on Eastern Head, Western Head, and around Duck Harbor. The beaches which do occur are

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usually boulder-strewn and gravelly. Salt marshes occupy the shores of some of the coves.

Isle au Haut lies within the central and eastern sector of the coastal climatic section of Maine as described by Fobes (1946). In many ways this area is typical of any moist, north temperate region and is characterized by warm days and cool nights during the summer months. As usual in coastal areas, the sea exerts an important moderating influence on the island's climate, making it generally more equable than that of inland areas. This has the effect of reducing the summer and winter extremes of temperature. Consequently the growing season is prolonged. This prolongation of the growing season on the one hand creates a climate suitable for certain plants of southern affinities. On the other hand, the frequency of fogs together with the effects of cold sea water buffeting exposed shores and headlands create conditions similar to those in more northern regions. These exposed shores provide habitats for plants of more boreal and arctic areas.

In the early decades of this century a number of well known botanists visited Isle au Haut. Mr. Nathaniel T. Kidder of Milton, Massachusetts, collected widely on the island roughly from 1900 to 1933. His notes and specimens are deposited in the library and herbarium of the New England Botanical Club. The New England Botanical Club Herbarium also contains specimens collected by Dr. Albert F. Hill who made an extensive botanical survey of Isle au Haut from 1913 to 1919 in connection with the preparation of his *Vascular Flora of the Penobscot Bay Region* (Hill, 1919). In addition, Miss Kate Furbish of Brunswick, Maine, has left us a smaller, though valuable, collection of Isle au Haut plants dating from 1909.

No comprehensive investigation of the flora of Isle au Haut was made until the writer's *The Vascular Flora of Isle au Haut, Knox County, Maine* (University of New Hampshire M. S. Thesis, unpubl.). This flora contained an annotated list of 724 taxa of vascular plants known to have occurred on Isle au Haut. It was based on collections made

by the writer in 1968 and 1969 all of which are deposited in the herbarium of the University of New Hampshire, and on previous collections if corroborated by herbarium specimens. The following list includes thirty-one additional taxa. These records are based on specimens recently found in a collection of Isle au Haut plants made by Nathaniel T. Kidder. This Kidder collection is a small portion of the Herbarium of the Portland Society of Natural History recently acquired on an extended loan basis by the University of New Hampshire Herbarium (NHA).

With a few exceptions, the nomenclature of the Spermatophytes employed in the following list essentially is that of *Gray's Manual of Botany* (8th ed., 1950). Pteridophyte nomenclature, however, follows Seymour (1969).

LIST OF PLANTS OF ISLE AU HAUT[1]

**Equisetum arvense* L., var. *arvense*
E. sylvaticum L., var. *pauciramosum* Milde
E. sylvaticum L., var. *pauciramosum* Milde, forma *multiramosum* Fern.
Lycopodium Selago L., var. *appressum* Desv.
L. lucidulum Michx., var. *lucidulum*
L. lucidulum Michx., var. *occidentale* (Clute) L. R. Wilson
L. inundatum L.
**L. annotinum* L., var. *annotinum*
L. annotinum L., var. *acrifolium* Fern.
**L. clavatum* L., var. *clavatum*
L. clavatum L., var. *megastachyon* Fern. & Bissell
**L. obscurum* L., forma *obscurum*
**L. obscurum* L., forma *dendroideum* (Michx.) Blomq. & Corr.

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[1]Those taxa preceded by an asterisk (*) are known to have occurred on Isle au Haut in 1968-69. Those marked by two asterisks (**) were not included in Wise, 1970 (unpubl.) and represent the thirty-one additional Kidder specimens recently discovered in the Portland Society of Natural History collection. Taxa preceded by a plus sign (+) were collected on Isle au Haut in 1968-69, and are not known to have been collected there previously.

L. complanatum L., var. *flabelliforme* Fern.
L. tristachyum Pursh
Selaginella rupestris (L.) Spring
Isoëtes muricata Dur.
Botrychium multifidum (Gmel.) Rupr., var. *intermedium* (D. C. Eat.) Farw.
B. dissectum Spreng., forma *dissectum*
B. dissectum Spreng., forma *obliquum* (Muhl.) Fern.
+*B. matricariaefolium* A. Br.
**Osmunda regalis* L., var. *spectabilis* (Willd.) Gray
**O. Claytoniana* L.
**O. cinnamomea* L.
Cystopteris fragilis (L.) Bernh., var. *Mackayii* Lawson
**Onoclea sensibilis* L.
+*Thelypteris palustris* (Salisb.) Schott, var. *pubescens* (Lawson) Fern.
+*T. simulata* (Davenp.) Nieuwl.
**T. noveboracensis* (L.) Nieuwl.
**T. Phegopteris* (L.) Slosson
**Gymnocarpium Dryopteris* (L.) Newm.
**Dryopteris spinulosa* (O. F. Muell.) Watt. var. *intermedia* (Muhl.) Underw.
**D. spinulosa* (O. F. Muell.) Watt, var. *americana* (Fisch.) Fern.
**D. cristata* (L.) Gray
**D. marginalis* (L.) Gray
Polystichum acrostichoides (Michx.) Schott
**Dennstaedtia punctilobula* (Michx.) Moore
Athyrium Filix-femina (L.) Roth, var. *Michauxii* (Spreng.) Farw.
A. Filix-femina (L.) Roth, var. *Michauxii* (Spreng.) Farw., forma *elatius* (Link) Clute
+*A. Filix-femina* (L.) Roth, var. *Michauxii* (Spreng.) Farw., forma *rubellum* (Gilbert) Farw.
**Pteridium aquilinum* (L.) Kuhn, var. *latiusculum* (Desv.) Underw.
**Polypodium virginianum* L.
Taxus canadensis Marsh.

**Abies balsamea* (L.) Mill.
***Abies balsamea* (L.) Mill., var. *phanerolepis* Fern.
**Tsuga canadensis* (L.) Carr.
**Picea glauca* (Moench) Voss
**P. rubens* Sarg.
**P. mariana* (Mill.) BSP
**Larix laricina* (DuRoi) K. Koch
**Pinus Strobus* L.
**P. resinosa* Ait.
**P. rigida* Mill.
**Thuja occidentalis* L.
**Juniperus communis* L., var. *depressa* Pursh
**J. horizontalis* Moench
**Typha latifolia* L.
**Sparganium americanum* Nutt.
S. chlorocarpum Rydb., var. *chlorocarpum*
**S. chlorocarpum* Rydb., var. *acaule* (Beeby) Fern.
S. angustifolium Michx.
S. minimum (Hartm.) Fries
Zostera marina L., var. *stenophylla* Aschers. & Graebn.
**Potamogeton epihydrus* Raf., var. *Nuttallii* (C. & S.) Fern.
P. Oakesianus Robbins.
**Triglochin maritima* L.
T. palustris L.
Alisma triviale Pursh
Sagittaria graminea Michx.
**Festuca rubra* L., var. *rubra*
F. rubra L., var. *rubra*, forma *megastachys* (Gaudin) Holmb.
F. elatior L.
+F. elatior L., forma *aristata* Holmb.
Puccinellia maritima (Huds.) Parl.
**P. paupercula* (Holm.) Fern. & Weath., var. *alaskana* (Scribn. & Merr.) Fern. & Wieg.
**Glyceria canadensis* (Michx.) Trin.
**G. laxa* Scribn.
**G. striata* (Lam.) Hitchc., var. *striata*

G. striata (Lam.) Hitchc., var. *stricta* (Scribn.) Fern.
**Poa annua* L.
**P. compressa* L.
**P. pratensis* L.
P. nemoralis L.
**Dactylis glomerata* L., var. *glomerata*
D. glomerata L., var. *ciliata* Peterm.
**Molinia caerulea* (L.) Moench
Cynosurus cristatus L.
+*Agropyron trachycaulum* (Link) Malte, var. *majus* (Vasey) Fern.
A. trachycaulum (Link) Malte, var. *novae-angliae* (Scribn.) Fern.
**A. repens* (L.) Beauv., var. *repens*
A. repens (L.) Beauv., var. *repens*, forma *aristatum* (Schum.) Holmb.
A. repens (L.) Beauv., var. *repens*, forma *trichorrachis* Rohlena
A. repens (L.) Beauv., var. *repens*, forma *pilosum* (Scribn.) Fern.
+*Lolium multiflorum* Lam.
Hordeum jubatum L.
H. vulgare L.
***Triticum aestivum* L.
Secale cereale L.
**Elymus arenarius* L., var. *villosus* Mey.
**E. virginicus* L., var. *virginicus*
E. virginicus L., var. *virginicus*, forma *hirsutiglumis* (Scribn.) Fern.
Avena sativa L.
**Deschampsia flexuosa* (L.) Trin., var. *flexuosa*
+*D. flexuosa* (L.) Trin., var. *flexuosa*, forma *flavescens* Sylven
+*D. caespitosa* (L.) Beauv., var. *parviflora* (Thuill.) Richter
**Danthonia spicata* (L.) Beauv., var. *spicata*
D. compressa Aust.

**Calamagrostis canadensis* (Michx.) Nutt., var. *canadensis*
Agrostis alba L., var. *alba*
A. alba L., var. *palustris* (Huds.) Pers.
**A. tenuis* Sibth.
**A. scabra* Willd.
A. perennans (Walt.) Tuckerm.
Cinna latifolia (Trev.) Griseb.
**Phleum pratense* L.
**Alopecurus pratensis* L.
**Muhlenbergia uniflora* (Muhl.) Fern.
+Brachyelytrum erectum (Schreb.) Beauv., var. *erectum*
B. erectum (Schreb.) Beauv., var. *septentrionale* Babel
Oryzopsis asperifolia Michx.
**O. canadensis* (Poir.) Torr.
**Spartina pectinata* Link
**S. alterniflora* Loisel.
**S. patens* (Ait.) Muhl.
**S. × caespitosa* A. A. Eat.
**Anthoxanthum odoratum* L.
**Leersia oryzoides* (L.) Sw.
Panicum capillare L., var. *occidentale* Rydb.
**P. boreale* Nash
P. lanuginosum Ell., var. *implicatum* (Scribn.) Fern.
+P. lanuginosum Ell., var. *septentrionale* Fern.
+P. subvillosum Ashe
Echinochloa crusgalli (L.) Beauv.
**Setaria glauca* (L.) Beauv.
S. viridis (L.) Beauv.
**Dulichium arundinaceum* (L.) Britt.
Eleocharis parvula (R. & S.) Link
E. obtusa (Willd.) Schultes
**E. halophila* Fern. & Brack.
**E. tenuis* (Willd.) Schultes
**?E. elliptica* Kunth.
+Scirpus cespitosus L., var. *callosus* Bigel.
S. americanus Pers.
S. acutus Muhl.

*S. *paludosus* Nels., var. *atlanticus* Fern.
*S. *rubrotinctus* Fern.
*S. *atrovirens* Willd., var. *georgianus* (Harper) Fern.
S. *cyperinus* (L.) Kunth, var. *cyperinus*
*S. *cyperinus* (L.) Kunth, var. *pelius* Fern.
S. *cyperinus* (L.) Kunth, var. *pelius* Fern., forma *condensatus* (Fern.) S. F. Blake
S. *pedicellatus* Fern.
S. *atrocinctus* Fern.
Eriophorum spissum Fern.
*E. *tenellum* Nutt.
*E. *angustifolium* Honckeny
*E. *virginicum* L.
**Rhynchospora alba* (L.) Vahl
**Carex stipata* Muhl.
*C. *trisperma* Dew., var. *trisperma*
C. *trisperma* Dew., var. *Billingsii* Knight
C. *Mackenziei* Krecz.
C. *canescens* L., var. *disjuncta* Fern.
C. *canescens* L., var. *subloliacea* Laestad.
*C. *brunnescens* (Pers.) Poir., var. *sphaerostachya* (Tuckerm.) Kukenth.
C. *Deweyana* Schwein.
C. *exilis* Dew.
*C. *atlantica* Bailey
*C. *cephalantha* (Bailey) Bickn.
**C. *angustior* Mackenz.
*C. *scoparia* Schkuhr, var. *scoparia*
*C. *Crawfordii* Fern.
C. *tenera* Dew.
**C. *cumulata* (Bailey) Mackenz.
**C. *hormathodes* Fern.
C. *hormathodes* Fern., forma *invisa* (W. Boott) Fern.
C. *adusta* Boott
+C. *argyrantha* Tuckerm.
**C. *aenea* Fern.
C. *leptalea* Wahlenb.
C. *communis* Bailey

*C. *Emmonsii* Dew.
**C. *artitecta* Mackenz.
C. *novae-angliae* Schwein.
C. *deflexa* Hornem.
+C. *umbellata* Schkuhr.
C. *paleacea* Wahlenb.
C. *paleacea* Wahlenb., forma *erectiuscula* Fern.
*C. *nigra* (L.) Reichard, var. *nigra*
C. *nigra* (L.) Reichard, var. *strictiformis* (Bailey) Fern.
*C. *stricta* Lam., var. *stricta*
*C. *paupercula* Michx., var. *irrigua* (Wahlenb.) Fern.
C. *Houghtonii* Torr.
*C. *pallescens* L., var. *neogaea* Fern.
*C. *arctata* Boott
*C. *debilis* Michx., var. *Rudgei* Bailey
C. *conoidea* Schkuhr
*C. *panicea* L.
+C. *laxiflora* Lam.
*C. *ormostachya* Wieg.
C. *leptonervia* Fern.
C. *flava* L.
*C. *viridula* Michx.
C. *pauciflora* Lightf.
*C. *lurida* Wahlenb.
*C. *folliculata* L.
C. *intumescens* Rudge, var. *Fernaldii* Bailey
*C. *rostrata* Stokes
Arisaema Stewardsonii Britt.
**Calla palustris* L.
**Symplocarpus foetidus* (L.) Nutt.
Lemna trisulca L.
**Eriocaulon septangulare* With.
**Juncus bufonius* L., var. *bufonius*
**J. Gerardi* Loisel., var. *Gerardi*
**J. tenuis* Willd., var. *tenuis*
**J. Greenei* Oakes & Tuckerm.
**J. effusus* L., var. *compactus* Lej. & Court.

J. effusus L., var. *decipiens* Buchenau
**J. effusus* L., var. *Pylaei*
**J. balticus* Willd., var. *littoralis* Engelm.
**J. canadensis* J. Gay, var. *canadensis*
**J. brevicaudatus* (Engelm.) Fern.
J. militaris Bigel.
**J. articulatus* L., var. *articulatus*
J. pelocarpus Mey.
**Luzula acuminata* Raf.
**L. multiflora* (Retz.) Lejeune, var. *multiflora*
**L. multiflora* (Retz.) Lejeune, var. *fusconigra* Celak.
***L. multiflora* (Retz.) Lejeune, var. *acadiensis* Fern.
**Allium Schoenoprasum* L., var. *sibiricum* (L.) Hartm.
Hemerocallis fulva L.
**Clintonia borealis* (Ait.) Raf.
Smilacina racemosa (L.) Desf.
S. trifolia (L.) Desf.
**Maianthemum canadense* Desf.
**Streptopus roseus* Michx., var. *perspectus* Fassett
**Polygonatum pubescens* (Willd.) Pursh
Medeola virginiana L.
Trillium undulatum Willd.
**Sisyrinchium montanum* Greene, var. *crebrum* Fern.
Iris Hookeri Penny
**I. versicolor* L.
**Cypripedium acaule* Ait.
**Habenaria clavellata* (Michx.) Spreng., var. *ophioglossoides* Fern.
H. orbiculata (Pursh) Torr.
H. macrophylla Goldie
H. obtusata (Pursh) Richards
**H. lacera* (Michx.) R. Br.
H. psycodes (L.) Sw.
**H. fimbriata* (Ait.) R. Br.
**Pogonia ophioglossoides* (L.) Ker
**Calopogon pulchellus* (Salisb.) R. Br.
Arethusa bulbosa L.
***Spiranthes gracilis* (Bigel.) Beck

*S. *cernua* (L.) Richard, var. *cernua*
*S. *cernua* (L.) Richard, var. *ochroleuca* (Rydb.) Ames
S. *Romanzoffiana* Cham.
*Goodyera *repens* (L.) R. Br., var. *ophioides* Fern.
Corallorhiza *trifida* Chatelain, var. *verna* (Nutt.) Fern.
*C. *maculata* Raf.
*Malaxis *unifolia* Michx.
Liparis *Loeselii* (L.) Richard
Salix *lucida* Muhl., var. *lucida*
S. *alba* L., var. *vitellina* (L.) Stokes
S. *rigida* Muhl.
*S. *Bebbiana* Sarg.
*S. *discolor* Muhl.
**S. *humilis* Marsh.
S. *gracilis* Anderss., var. *textoris* Fern.
S. *coactilis* Fern.
*Populus *tremuloides* Michx., var. *tremuloides*
*P. *tremuloides* Michx., var. *magnifica* Vict.
*P. *grandidentata* Michx.
P. *balsamifera* L.
*P. × *gileadensis* Rouleau
*Myrica *Gale* L., var. *subglabra* (Chev.) Fern.
*M. *pensylvanica* Loisel.
*Comptonia *peregrina* (L.) Coult.
*Ostrya *virginiana* (Mill.) K. Koch
*Betula *alleghaniensis* Britt. (= *B. *lutea* Michx. f. of *Gray's* Manual)
*B. *populifolia* Marsh.
B. *caerulea-grandis* Blanch.
*B. *populifolia* Marsh. × *B. *papyrifera* Marsh., var. *papyrifera*
*B. *papyrifera* Marsh., var. *papyrifera*
*B. *papyrifera* Marsh., var. *cordifolia* (Regel) Fern.
*Alnus *crispa* (Ait.) Pursh, var. *mollis* Fern.
A. *rugosa* (DuRoi) Spreng., var. *rugosa*
*A. *rugosa* (DuRoi) Spreng., var. *americana* (Regel) Fern.
*Fagus *grandifolia* Ehrh.

**Quercus rubra* L.
Humulus Lupulus L.
***Urtica viridis* Rydb.
**U. dioica* L.
U. urens L.
**Arceuthobium pusillum* Peck
Rumex altissimus Wood.
R. pallidus Bigel.
R. domesticus Hartm.
R. orbiculatus Gray
**R. crispus* L.
**R. Acetosella* L., var. *Acetosella*
**Polygonum aviculare* L., var. *vegetum* Ledeb.
**P. aviculare* L., var. *littorale* (Link) W. D. J. Koch
P. lapathifolium L.
P. scabrum Moench
P. Careyi Olney
**P. Hydropiper* L.
**P. Persicaria* L.
P. punctatum Ell.
**P. sagittatum* L.
**P. cilinode* Michx.
P. cilinode Michx., forma *erectum* (Peck) Fern.
***P. Convolvulus* L., var. *Convolvulus*
P. Convolvulus L., var. *subalatum* Lej. & Court.
Fagopyrum sagittatum Gilib.
**Chenopodium album* L.
**Atriplex patula* L., var. *patula*
**A. patula* L., var. *hastata* (L.) Gray
**A. patula* L., var. *littoralis* (L.) Gray
+A. glabriuscula Edmondston
**Salicornia europaea* L., var. *europaea*
S. europaea L., var. *prostrata* (Pall.) Fern.
**Suaeda maritima* (L.) Dumort.
+S. linearis (Ell.) Moq.
**Salsola Kali* L., var. *Kali*
Amaranthus retroflexus L.
A. albus L.

Portulaca oleracea L.
Montia lamprosperma Cham.
**Spergularia rubra* (L.) J. & C. Presl.
S. marina (L.) Griseb., var. *leiosperma* (Kindb.) Gurke
**S. canadensis* (Pers.) Don
**Spergula arvensis* L.
**Sagina procumbens* L.
S. nodosa (L.) Fenzl., var. *pubescens* Mert. & Koch
**Arenaria lateriflora* L.
A. peploides L., var. *robusta* Fern.
**A. groenlandica* (Retz.) Spreng.
Stellaria media (L.) Cyrillo
S. graminea L.
S. calycantha (Ledeb.) Bong., var. *isophylla* Fern.
**S. calycantha* (Ledeb.) Bong., var. *floribunda* Fern.
**Cerastium vulgatum* L.
C. arvense L.
+*C. tomentosum* L.
***Lychnis alba* Mill.
***Silene Armeria* L.
S. noctiflora L.
Saponaria officinalis L.
**Dianthus deltoides* L.
D. plumarius L.
**Nuphar variegatum* Engelm.
**Nymphaea odorata* Ait.
**Ranunculus Cymbalaria* Pursh
R. repens L.
**R. acris* L., var. *acris*
**R. bulbosus* L.
Thalictrum polygamum Muhl.
Clematis virginiana L.
**Coptis groenlandica* (Oeder) Fern.
Aquilegia vulgaris L.
Actaea rubra (Ait.) Willd.
**A. pachypoda* Ell.
**Berberis Thunbergii* DC
**Corydalis sempervirens* (L.) Pers.

**Thlaspi arvense* L.
**Iberis umbellata* L.
Lepidium campestre (L.) R. Br.
L. densiflorum Schrad.
**Capsella Bursa-pastoris* (L.) Medic.
**Cakile edentula* (Bigel.) Hook.
Raphanus Raphanistrum L.
***R. sativus* L.
Brassica Kaber (DC.) L. C. Wheeler, var. *pinnatifida* (Stokes) L. C. Wheeler
B. juncea (L.) Coss.
**B. nigra* (L.) Koch
B. Rapa L.
**Sisymbrium officinale* (L.) Scop., var. *leiocarpum* DC.
S. altissimum L.
Hesperis matronalis L.
Erysimum cheiranthoides L.
Rorippa sylvestris (L.) Bess.
R. islandica (Oeder) Borbas, var. *Fernaldiana* Butt. & Abbe
Armoracia lapathifolia Gilib.
**Barbarea vulgaris* R. Br., var. *arcuata* (Opiz) Fries
B. vulgaris R. Br., var. *brachycarpa* Rouy & Foucaud
Cardamine pensylvanica Muhl.
***C. parviflora* L., var. *arenicola* (Britt.) O. E. Schulz
**Sarracenia purpurea* L.
**Drosera intermedia* Hayne
**D. rotundifolia* L., var. *rotundifolia*
***Sedum purpureum* (L.) Link
S. Rosea (L.) Scop.
***Sempervivum tectorum* L.
**Ribes hirtellum* Michx., var. *hirtellum*
**R. hirtellum* Michx., var. *calcicola* Fern.
R. lacustre (Pers.) Poir.
**R. glandulosum* Grauer
R. triste Pall.
R. sativum Syme
**Hamamelis virginiana* L., var. *virginiana*

**Spiraea latifolia* (Ait.) Borkh.
**S. tomentosa* L.
+*S. japonica* L.f., cv. *Anthony Waterer*
**Pyrus Malus* L.
**P. floribunda* Lindl.
**P. melanocarpa* (Michx.) Willd.
**P. americana* (Marsh.) DC.
**P. decora* (Sarg.) Hyland
**P. Aucuparia* (L.) Gaertn.
Amelanchier stolonifera Wieg.
***A. canadensis* (L.) Medic.
A. arborea (Michx. f.) Fern.
**A. laevis* Wieg.
***A. laevis* Wieg. × *A. canadensis* (L.) Medic.
A. Bartramiana (Tausch) Roemer × *A. laevis* Wieg.
+*Crataegus chrysocarpa* Ashe
**C. Jonesae* Sarg.
**C. macrosperma* Ashe
**C. succulenta* Link
**Fragaria virginiana* Duchesne, var. *virginiana*
F. virginiana Duchesne, var. *terrae-novae* (Rydb.) Fern. & Wieg.
F. × *Ananassa* Duchesne
**Potentilla tridentata* Ait.
P. tridentata Ait., forma *aurora* Graustein
P. palustris (L.) Scop., var. *villosa* (Pers.) Lehm.
P. argentea L.
P. pectinata Raf.
**P. norvegica* L.
P. canadensis L.
**P. simplex* Michx., var. *simplex*
P. simplex Michx., var. *calvescens* Fern.
**P. Egedei* Wormsk., var. *groenlandica* (Tratt.) Polunin
**Filipendula Ulmaria* (L.) Maxim.
Geum aleppicum Jacq., var. *strictum* (Ait.) Fern.
Rubus pubescens Raf.
***Rubus idaeus* L., var. *idaeus*
R. idaeus L., var. *strigosus* (Michx.) Maxim.

R. idaeus L., var. *heterolasius* Fern.
**R. idaeus* L., var. *canadensis* Richards.
R. recurvicaulis Blanch.
R. recurvicaulis Blanch. × *R. setosus* Bigel.
**R. hispidus* L., var. *hispidus*
R. setosus Bigel. × *R. allegheniensis* Porter
\+ ?*R. semisetosus* Blanch.
R. canadensis L.
**R. allegheniensis* Porter, var. *allegheniensis*
R. frondosus Bigel.
R. pensilvanicus Poir.
Dalibarda repens L.
**Rosa nitida* Willd.
**R. virginiana* Mill.
***R. virginiana* Mill. × *R. nitida* Willd.
**R. rugosa* Thunb.
***R. cinnamomea* L.
Prunus maritima L.
**P. pensylvanica* L. f.
***P. Avium* L.
**P. virginiana* L.
Lupinus polyphyllus Lindl.
Trifolium arvense L.
T. pratense L.
\+ *T. pratense* L., forma *pilosum* (Griseb.) Hayek
**T. repens* L.
T. hybridum L., var. *elegans* (Savi) Boiss.
**T. agrarium* L.
**T. procumbens* L.
Medicago lupulina L.
Vicia angustifolia Reichard, var. *segetalis* (Thuill.) W. D. J. Koch
**V. Cracca* L.
**Lathyrus japonicus* Willd., var. *glaber* (Ser.) Fern.
L. japonicus Willd., var. *pellitus* Fern.
L. palustris L., var. *pilosus* (Cham.) Ledeb.
Linum usitatissimum L.
**Oxalis montana* Raf.

O. europaea Jord., var. *europaea*
**O. europaea* Jord., var. *europaea*, forma *cymosa* (Small) Wieg.
Geranium Bicknellii Britt.
G. molle L.
**G. Robertianum* L.
Polygala sanguinea L.
**Euphorbia Cyparissias* L.
E. Peplus L.
**Empetrum nigrum* L.
**Corema Conradii* Torr.
**Rhus typhina* L.
**R. radicans* L., var. *radicans*
**Ilex verticillata* (L.) Gray, var. *verticillata*
**I. glabra* (L.) Gray
**Nemopanthus mucronata* (L.) Trel.
+Celastrus orbiculatus Thunb.
**Acer spicatum* Lam.
**A. pensylvanicum* L.
**A. saccharum* Marsh.
**A. rubrum* L., var. *rubrum*
+A. rubrum L., var. *rubrum*, forma *tomentosum* (Desf.) Dansereau
**A. rubrum* L., var. *trilobum* K. Koch
**Impatiens capensis* Meerb.
Parthenocissus quinquefolia (L.) Planch.
+P. inserta (Kerner) K. Fritsch
***Malva neglecta* Wallr.
**Hypericum perforatum* L.
H. boreale (Britt.) Bickn.
H. mutilum L., var. *parviflorum* (Willd.) Fern.
H. majus (Gray) Britt.
**H. canadense* L.
**H. dissimulatum* Bickn.
**H. gentianoides* (L.) BSP
H. virginicum L., var. *virginicum*
**H. virginicum* L., var. *Fraseri* (Spach) Fern.
Elatine americana (Pursh) Arn.

***Hudsonia ericoides* L.
H. tomentosa Nutt., var. *intermedia* Peck
**Lechea intermedia* Leggett, var. *intermedia*
L. intermedia Leggett, var. *juniperina* (Bickn.) Robins.
**Viola cucullata* Ait.
**V. septentrionalis* Greene
V. fimbriatula Sm.
**V. pallens* (Banks) Brainerd
V. incognita Brainerd, var. *incognita*
+*V. incognita* Brainerd, var. *Forbesii* Brainerd
V. blanda Willd.
**V. lanceolata* L.
V. primulifolia L., var. *acuta* (Bigel.) T. & G.
Decodon verticillatus (L.) Ell., var. *laevigatus* T. & G.
**Epilobium angustifolium* L.
E. strictum Muhl.
E. leptophyllum Raf., forma *umbrosum* (Haussk.) Fern.
E. palustre L., var. *oliganthum* (Michx.) Fern.
E. coloratum Biehler
+*E. glandulosum* Lehm., var. *adenocaulon* (Haussk.) Fern.
**Oenothera biennis* L., var. *biennis*
O. parviflora L.
**O. perennis* L.
**Circaea alpina* L.
**Aralia hispida* Vent.
**A. nudicaulis* L.
Hydrocotyle americana L.
Cicuta maculata L.
+*Carum Carvi* L.
**Ligusticum scothicum* L.
**Coelopleurum lucidum* (L.) Fern.
**Heracleum maximum* Bartr.
**Daucus Carota* L.
**Cornus canadensis* L.
C. stolonifera Michx.
C. alternifolia L. f.

Chimaphila umbellata (L.) Bart., var. *cisatlantica* Blake
**Moneses uniflora* (L.) Gray
Pyrola secunda L.
P. virens Schweigger, forma *paucifolia* Fern.
**P. elliptica* Nutt.
P. rotundifolia L., var. *americana* (Sweet) Fern.
**Monotropa uniflora* L.
M. Hypopithys L.
**Ledum groenlandicum* Oeder
**Rhododendron canadense* (L.) Torr.
**Kalmia angustifolia* L.
K. polifolia Wang.
**Cassandra calyculata* (L.) D. Don, var. *angustifolia* (Ait.) Rehd. (= *Chamaedaphne calyculata* (L.) Moench, var. *angustifolia* (Ait.) Rehd. of Gray's Manual).
**Gaultheria procumbens* L.
**G. hispidula* (L.) Bigel.
**Arctostaphylos Uva-ursi* (L.) Spreng., var. *coactilis* Fern. & Mack.
**Gaylussacia dumosa* (Andr.) T. & G., var. *Bigeloviana* Fern.
+*G. baccata* (Wang.) K. Koch
Vaccinium myrtilloides Michx.
+*V. angustifolium* Ait., var. *angustifolium*
V. angustifolium Ait., var. *laevifolium* House
V. angustifolium Ait., var. *nigrum* (Wood) Dole
V. corymbosum L., var. *albiflorum* (Hook.) Fern.
**V. Vitis-Idaea* L., var. *minus* Lodd.
V. Oxycoccos L.
**V. macrocarpon* Ait.
**Lysimachia quadrifolia* L.
L. × *producta* (Gray) Fern.
**L. terrestris* (L.) BSP, var. *terrestris*
**Trientalis borealis* Raf.
**Glaux maritima* L., var. *maritima*
G. maritima L., var. *obtusifolia* Fern.
**Limonium Nashii* Small

**Fraxinus americana* L., var. *americana*
F. pennsylvanica Marsh., var. *subintegerrima* (Vahl) Fern.
**Syringa vulgaris* L.
**Ligustrum amurense* Carr.
Bartonia virginica (L.) BSP
**B. paniculata* (Michx.) Muhl., var. *intermedia* Fern.
**Nymphoides cordata* (Ell.) Fern.
**Apocynum androsaemifolium* L.
**Asclepias incarnata* L., var. *pulchra* (Ehrh.) Pers.
**Convolvulus sepium* L., var. *sepium*
**Cuscuta Gronovii* Willd.
Myosotis sylvatica Hoffm.
M. arvensis (L.) Hill
**Mertensia maritima* (L.) S. F. Gray
Verbena hastata L.
**Teucrium occidentale* Gray, var. *boreale* (Bickn.) Fern.
Scutellaria lateriflora L.
**S. epilobiifolia* A. Hamilton
Nepeta Cataria L.
Glechoma hederacea L., var. *hederacea*
**G. hederacea* L., var. *micrantha* Moricand
**Prunella vulgaris* L., var. *lanceolata* (Bart.) Fern.
P. vulgaris L., var. *lanceolata* (Bart.) Fern., forma *iodocalyx* Fern.
Leonurus Cardiaca L.
**Galeopsis Tetrahit* L., var. *bifida* (Boenn.) Lej. & Court.
**Hedeoma pulegioides* (L.) Pers.
**Lycopus uniflorus* Michx.
L. americanus Muhl.
Mentha piperita L.
M. cardiaca Baker
M. arvensis L., var. *arvensis*
**M. arvensis* L., var. *villosa* (Benth.) S. R. Stewart
**Solanum Dulcamara* L.
***S. nigrum* L.
S. rostratum Dunal
**Verbascum Thapsus* L.

Linaria vulgaris Hill
**L. canadensis* (L.) Dumont
Scrophularia lanceolata Pursh
Veronica serpyllifolia L.
**V. officinalis* L.
V. peregrina L., var. *xalapensis* (HBK.) St. John & Warren
V. arvensis L.
**Melampyrum lineare* Desr., var. *lineare*
M. lineare Desr., var. *americanum* (Michx.) Beauverd
Euphrasia Randii Robins.
E. canadensis Townsend
Odontites serotina (Lam.) Dum.
**Rhinanthus Crista-galli* L., var. *Crista-galli*
Epifagus virginiana (L.) Bart.
**Utricularia geminiscapa* Benj.
U. cornuta Michx.
**Plantago major* L., var. *major*
P. major L., var. *Pilgeri* Domin
**P. juncoides* Lam., var. *decipiens* (Barneoud) Fern.
**P. oliganthos* R. & S.
***P. lanceolata* L.
P. altissima L.
**Galium Aparine* L.
**G. triflorum* Michx.
G. verum L.
**G. palustre* L.
G. trifidum L.
**G. tinctorium* L., var. *tinctorium*
Mitchella repens L.
**Houstonia caerulea* L.
**Diervilla Lonicera* Mill.
Lonicera villosa (Michx.) R. & S., var. *Solonis* (Eat.) Fern.
L. villosa (Michx.) R. & S., var. *calvescens* (Fern. & Wieg.) Fern.
**L. canadensis* Bartr.
+Symphoricarpos albus (L.) Blake, var. *albus*

S. albus (L.) Blake, var. *laevigatus* (Fern.) Blake
**Linnaea borealis* L., var. *americana* (Forbes) Rehd.
**Viburnum cassinoides* L.
**V. recognitum* Fern.
**Sambucus canadensis* L.
**S. pubens* Michx.
Echinocystis lobata (Michx.) T. & G.
Campanula rapunculoides L.
**C. rotundifolia* L.
**Lobelia inflata* L.
**L. Dortmanna* L.
**Eupatorium perfoliatum* L., var. *perfoliatum*
**Solidago bicolor* L.
**S. puberula* Nutt.
**S. sempervirens* L.
S. juncea Ait.
**S. uliginosa* Nutt., var. *linoides* (T. & G.) Fern.
S. uliginosa Nutt., var. *terrae-novae* (T. & G.) Fern.
**S. nemoralis* Ait.
**S. rugosa* Ait., var. *villosa* (Pursh) Fern.
**S. canadensis* L.
**S. graminifolia* (L.) Salisb., var. *Nuttallii* (Greene) Fern.
Aster macrophyllus L., var. *macrophyllus*
A. macrophyllus L., var. *velutinus* Burgess
A. cordifolius L., var. *cordifolius*
A. polycephalus Porter
A. radula Ait., var. *radula*
A. radula Ait., var. *strictus* (Pursh) Gray
A. lateriflorus (L.) Britt.
+*A. lateriflorus* (L.) Britt., var. *tenuipes* Wieg.
A. simplex Willd., var. *ramosissimus* (T. & G.) Cronq.
+*A. foliaceus* L.
**A. johannensis* Fern.
**A. novi-belgii* L., var. *novi-belgii*
**A. nemoralis* Ait.
**A. × Blakei* (Porter) House
**A. acuminatus* Michx.

*A. *umbellatus* Mill.
**Erigeron strigosus* Muhl., var. *strigosus*
E. canadensis L.
**Antennaria canadensis* Greene
A. neglecta Greene
A. neodioica Greene
A. munda Fern.
**A. fallax* Greene
A. Brainerdii Fern.
+*Anaphalis margaritacea* (L.) C. B. Clarke, var. *margaritacea*
+*A. margaritacea* (L.) C. B. Clarke, var. *intercedens* Hara
Gnaphalium obtusifolium L.
**G. uliginosum* L.
+*Ambrosia artemisiifolia* L., var. *artemisiifolia*
A. artemisiifolia L., var. *elatior* (L.) Descourtils
***A. artemisiifolia* L., var. *elatior* (L.) Descourtils, forma *villosa* Fern. and Grisc.
**Rudbeckia serotina* Nutt.
**Bidens frondosa* L.
B. frondosa L., forma *anomala* (Porter) Fern.
Galinsoga ciliata (Raf.) Blake
+*Achillea Millefolium* L.
Anthemis Cotula L.
A. tinctoria L.
Matricaria maritima L., var. *maritima*
M. Chamomilla L.
**M. matricarioides* (Less.) Porter
**Chrysanthemum Leucanthemum* L., var. *pinnatifidum* Lecoq. & Lamotte
C. Balsamita L.
Tanacetum vulgare L.
T. vulgare L., forma *crispum* (L.) Hayek
Artemisia vulgare L.
Petasites palmatus (Ait.) Gray
**Erechtites hieracifolia* (L.) Raf., var. *intermedia* Fern.
**E. hieracifolia* (L.) Raf., var. *praealta* (Raf.) Fern

Senecio vulgaris L.
**S. sylvaticus* L.
S. Robbinsii Oakes
***Arctium nemorosum* Lej. & Court.
**A. minus* (Hill) Bernh.
Echinops sphaerocephalus L.
**Cirsium vulgare* (Savi) Tenore
C. muticum Michx.
**C. arvense* (L.) Scop.
***Lapsana communis* L.
**Leontodon autumnalis* L., var. *autumnalis*
L. autumnalis L., var. *pratensis* (Link) W. D. J. Koch
Taraxacum erythrospermum Andrz.
**T. officinale* Weber, var. *officinale*
T. officinale Weber, var. *palustre* (Sm.) Blytt
Sonchus arvensis L.
**S. oleraceus* L.
**S. asper* (L.) Hill
Lactuca canadensis L., var. *canadensis*
L. canadensis L., var. *longifolia* (Michx.) Farw.
L. canadensis L., var. *latifolia* Ktze.
L. biennis (Moench) Fern.
**Prenanthes trifoliolata* (Cass.) Fern., var. *trifoliolata*
+P. trifoliolata (Cass.) Fern., var. *nana* (Bigel.) Fern.
P. altissima L.
P. altissima L., forma *hispidula* Fern.
Hieracium Pilosella L.
**H. aurantiacum* L.
**H. pratense* Tausch
H. florentinum All.
H. canadense Michx., var. *canadense*
H. paniculatum L.
H. scabrum Michx.

A close examination of the preceding list will reveal that the vascular flora of Isle au Haut is chiefly transitional in character and is generally typical of what has been termed the Canadian Transition Zone (Hill, 1923). This "zone" contains floristic elements from both the more northern

Boreal Region and the Alleghenian Region to the south. However, a few Carolinian plants of the southeastern coastal plain and a few Arctic plants are present on the island as well. These are of particular interest due to their markedly disjunct distributions.

The following plants of Coastal Plain and Arctic phytogeographic affinities were found to be present on Isle au Haut in 1968-69 and deserve special mention. Specimens are deposited in the herbarium of the University of New Hampshire (NHA).

COASTAL PLAIN PLANTS

Thelypteris simulata (Davenp.) Nieuwl.
Massachusetts Fern.

The Massachusetts Fern was found to be locally abundant in alder thickets at the edge of a bog at Moore's Harbor on the western side of Isle au Haut. While found in southwestern Nova Scotia the 1969 collections are the first Knox County records for this species and indicate a slight northeastern extension of range in the United States from Lincoln County, Maine.

Corema Conradii Torr. Broom-Crowberry.

This coastal plain relative of *Empetrum* was collected on Isle au Haut by Albert F. Hill in 1913. In 1968-69 it was frequently encountered on the rocky summits of Mt. Champlain and Black Dina.

Ilex glabra (L.) Gray Inkberry.

The inkberry was first collected on Isle au Haut by Nathaniel T. Kidder in 1922 (Kidder, 1923). It was found growing in the "Great Meadow" bog, and Mr. Kidder noted that it occurred in "considerable quantity, fifty plants or more". In 1969 the writer and Dr. A. R. Hodgdon found the plant still growing at the same site covering an area of about fifty by seventy-five feet. While quite abundant locally, the plants were small, low growing, and depauperate in aspect. These collections from Isle au Haut represent

the only known occurrence of *Ilex glabra* between Seabrook, New Hampshire (Hodgdon, 1955) and Nova Scotia (Kidder, 1923).

Bartonia paniculata (Michx.) Muhl., var. **intermedia** Fern.

In 1922 Kidder also collected this Coastal Plain plant in the same bog on Isle au Haut where he had found *Ilex glabra*. Though very infrequent in occurrence, it was still present in 1969. This station, therefore, remains the only one known for this variety of *B. paniculata* between Nova Scotia and the Blue Hills, Massachusetts (Fernald, 1921; Kidder, 1923; Seymour, 1969).

In addition to the above, **Hudsonia ericoides** L., a plant with a somewhat similar Coastal Plain distribution, was collected on Isle au Haut by Kidder in 1901 and 1926. The writer was unable to locate the collecting sites in 1968-69. Consequently the present occurrence of *Hudsonia ericoides* on Isle au Haut remains in doubt.

ARCTIC PLANTS

Scirpus cespitosus L., var. **callosus** Bigel.

Not previously reported from Isle au Haut, this plant of Arctic affinity was found to be quite common in moist depressions on the top of Duck Harbor Mountain. Other taxa of similar phytogeographic relationship also frequent at the same site were: *Arenaria groenlandica*, *Arctostaphylos Uva-ursi*, and *Empetrum nigrum*.

Mertensia maritima (L.) S. F. Gray

This plant of Arctic affinity was collected previously on Isle au Haut by Kidder in 1926. Though still present in 1969, it was represented only by a few depauperate plants found along the shore of Barred Harbor.

Three species of similar phytogeographic range: *Iris Hookeri*, *Montia lamprosperma*, and *Sedum Rosea*, though previously collected on Isle au Haut, were not found there in 1968-69.

INTRODUCED PLANTS

In addition to species having either Coastal Plain or

Arctic affinities, two introduced plants recently found on Isle au Haut deserve mention.

Molinia caerulea (L.) Moench

This European grass was first collected by Kidder on Point Lookout in 1918. Later collections were made by him at the same locality in 1919 and 1927. The writer and Dr. A. R. Hodgdon visited the site in 1969 and found the grass not only persisting but apparently spreading very successfully. The only other known collections of *Molinia* in Maine were made by E. P. Bicknell at Mt. Desert, Bar Harbor, and York Harbor in 1897. Curiously all three collections were made on August 25 — an admirable though suspect feat considering that York Harbor is some 150 miles from Mt. Desert Island (Dix, 1945).

Iberis umbellata L.

Very close to the *Molinia* locality this plant was found growing in considerable abundance in a filled in cellar-hole. Apparently once cultivated it presently is spreading successfully as a weed. The only other known record of *I. umbellata* from New England is a specimen in the New England Botanical Club Herbarium collected by A. S. Pease in Randolph, New Hampshire, in 1916.

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MANUAL OF THE VASCULAR PLANTS OF TEXAS[1]

This manual of the Texas flora is a monumental work and the authors, D. S. Correll and M. C. Johnston, as well as their collaborators, deserve the compliments of systematists on its publication. A definitive treatment of a large and complex flora (174 families, 1216 genera, 4839 species and 576 subspecies and varieties in Texas) must depend to a considerable extent upon the labors of predecessors. There has been a long and active series of collectors and publishers interested in Texas plants, and they have provided an excellent basis for a comprehensive flora. However, the special research on the Texas flora by the authors, and their extensive field experience with it, have brought to this publication an important element of personal knowledge. Fifty-six collaborators have provided the treatments of 20 families and of 38 separate genera. Both the authors and the collaborators are to be congratulated upon this productive cooperation.

The book is well made up and the format and typography make it easy to use. An introduction provides a brief account of the principal vegetation regions in Texas. This is followed by a key to the families and the taxonomic treatment of the flora, which encompasses 1700 pages. A brief appendix adds critical comments and some additional species from data obtained during the course of publication. The list of "Abbreviations of Authors' Names" deserves special mention. It is in fact far more than the title states. It includes birth and death dates, and a variety of other information such as the principal professional position, or other occupation, major publications, groups or floras studied, and sometimes mention of other significant contributions to botany. The inclusion of this information will

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[1]Correll, D. S. and M. C. Johnston. Manual of the vascular plants of Texas. xv + 1881 pp. frontispiece (the Texas Bluebonnet, *Lupinus subcarnosus*, in color), 3 maps, cloth. $30.00. (Contributions from the Texas Research Foundation, Edited by C. L. Lundell, vol. 6). Texas Research Foundation, Renner, Texas. 1970.

remove (for many users of the Manual) the anonymity of the authors of plant names and it will relate the authors to their botanical work. It also provides an introduction to the historical basis of the Manual.

A notable feature is the flexibility allowed in the taxonomic treatments. This is a commendable policy and much more is gained by it than from the consistency resulting from a rigidly imposed format. Extended discussion is not possible in a large manual, but the authors effectively have utilized departures from the normal format and brief comments in difficult species-groups to point out uncertainties and problems that need further study. This flexibility also has allowed the collaborators to express preferences, for example, subspecies are used by Raven and varieties by Shinners; hybrid formulas are used in *Quercus* by Muller; and Capparidaceae for the Caper Family by Iltis.

The flora of Texas is dominated by four major floristic elements. The most important in terms of area and economy is that of the Prairies and Plains, predominantly a flora of Gramineae, Leguminosae and Compositae. Two important floras extend into Texas from the east, the Appalachian-Ozark and the Coastal Plain. Together these provide the forests and woodlands of the eastern portion of the state that extend westward to the Cross-Timbers region. The Coastal Plain element also furnishes most of the species along the Gulf Coast. The Mexican flora is the most important in number of species and is of special interest because of its many endemics. This element dominates the mountains and arid valleys and basins of the Trans-Pecos region and is strongly represented elsewhere along the Rio Grande and on the Edwards Plateau. Almost half of the Pteridophyta, for example, belong to this element, largely due to the many species of *Pellaea*, *Cheilanthes* and *Notholaena*. Among other groups that show a similar geographic relation may be mentioned *Ephedra* and *Muhlenbergia*, and especially *Acacia*, *Mimosa*, *Heliotropium* and *Baccharis*.

A review in Rhodora of a flora of another part of the United States invites some comparison with the flora

treated in Gray's Manual. In the 8th Edition by M. L. Fernald, the area covered is about four times as large as Texas (it requires several northeastern states to do this); there are similar numbers of genera (1133 to 1216 in Texas) and species (5525 to 4839 in Texas). The relatively small differences in numbers could easily be due to different taxonomic viewpoints, so the two floras might well be considered nearly equivalent. There are, however, some significant differences. There are few large genera in Texas. *Panicum* with 68 species is the largest and only two others, *Carex* and *Euphorbia* have more than 50 species. *Cyperus* has 46 and there are eight other genera with more than 30 species. In the northeastern United States the largest genus is *Carex* with 267 species, and others such as *Panicum*, *Juncus*, *Salix*, *Rubus*, *Crataegus*, *Viola*, *Solidago* and *Aster* have over 50 species each. Genera with 30-50 species are *Potamogeton*, *Cyperus*, *Eleocharis*, *Scirpus*, *Polygonum*, *Ranunculus*, *etc.* Most of the larger genera have their primary strength in aquatic or marsh habitats. These genera are naturally not as well represented in Texas. For some reason their place is not taken by equally large genera of xeric habitats, although these are not lacking in Mexico.

The Manual of the Vascular Plants of Texas is a noteworthy achievement. It is a necessary guide to the Texas flora, but will be used as often beyond its geographic limits. It will certainly stimulate interest in Texas plants and further research on the rich Texas flora.

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THE VARIETIES OF SILPHIUM INTEGRIFOLIUM

WILBUR J. SETTLE AND T. RICHARD FISHER

The genus *Silphium* (Compositae) was described first by Linnaeus in 1753 in *Species Plantarum* which listed five species. Small (1933) recognized more than thirty species of *Silphium*. Perry (1937), who has written the only extensive taxonomic treatment of the genus, recognized 23 species and several varieties. T. R. Fisher and some of his students currently recognize 16 species.

All of the species of *Silphium* which have been studied are diploid ($2n=14$) (Figure 2). The plants reproduce sexually by outcrossing; selfing rarely occurs. Vegetative reproduction occurs from the perennial rhizomes. Apomixis has not been reported for the genus. Flowering occurs from June to September.

The genus occurs only in North America north of Mexico, ranging from Florida to Connecticut, northwest to the Dakotas, and southwest to Texas. *Silphium* is in the tribe Heliantheae which is characterized by radiate heads, herbaceous phyllaries, chaffy receptacles, and blunt anthers.

Small (1933) divided the genus into five sections on the basis of phyllary pubescence, grouping of inflorescences, and leaf position. Section I, *Perfoliata*, contained the species with perfoliate leaves; sections II and III, *Laciniata* and *Composita* respectively, contained the species with mostly basal leaves; sections IV and V, *Dentata* and *Integrifolia* respectively, contained the species with leafy stems. *Silphium integrifolium* is included in the section *Integrifolia*.

As a part of a more extensive study of *S. integrifolium*, field collections and herbarium material from FSU, GA, GH, MO, ND, NY, PH, TENN, WIS, WVA, and US were studied. See Lanjouw and Stafleu (1964) for abbreviations.

TAXONOMY

Silphium integrifolium Michx. Fl. Bor. Am. 2: 146. 1803. (Holotype: Hab. in regione Illinoensi. *A. Michaux*, P).

Figure 1. Photograph of *Silphium integrifolium* specimen. (Photograph by Wm. Anderson)

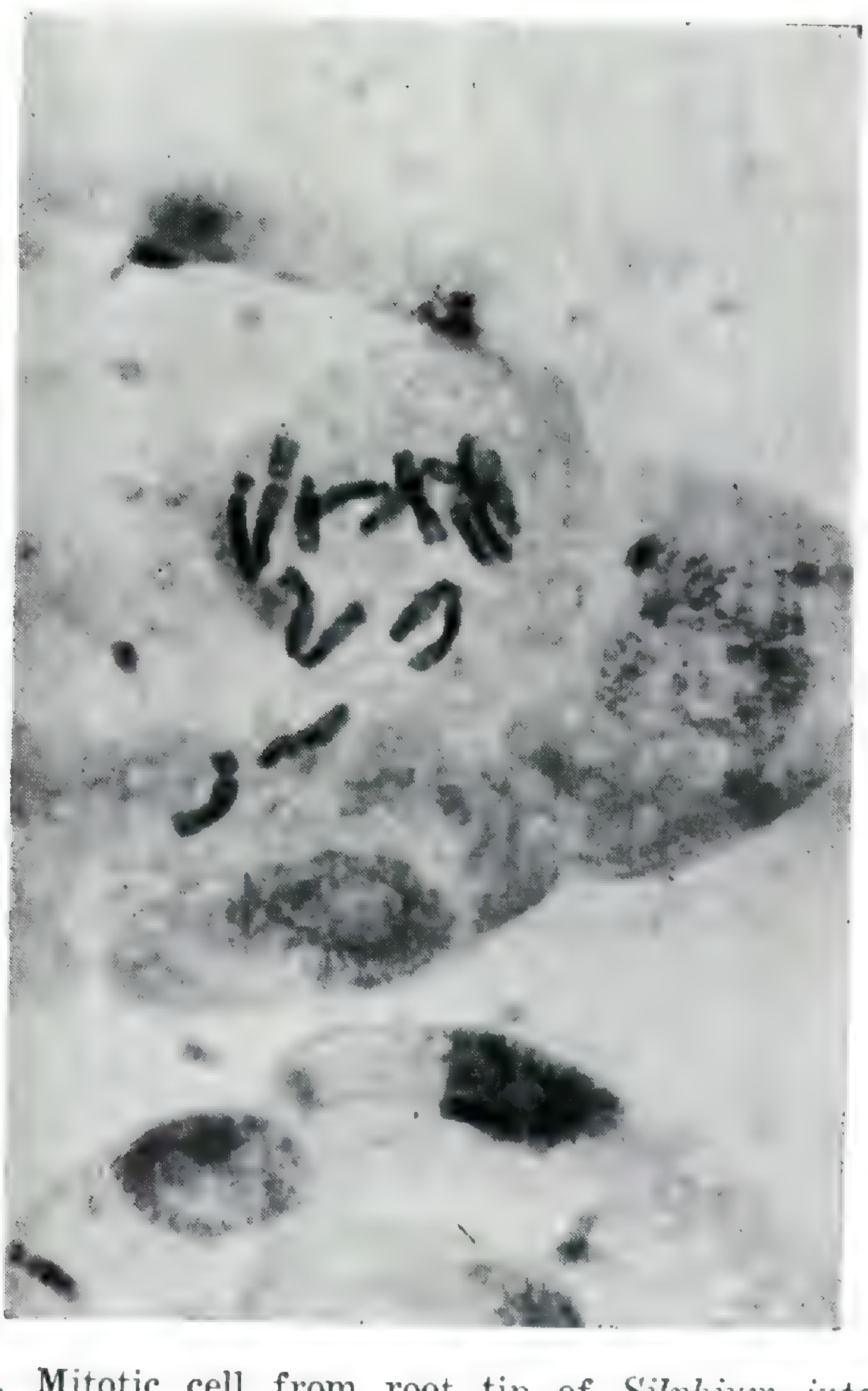

Figure 2. Mitotic cell from root tip of *Silphium integrifolium*, $2n=14$, *Fisher* 624. 1125 ×.

Silphium laevigatum Pursh, F. Am. Sept. 2: 578. 1814. (Lectotype: In Georgia, Fl. Am. Bor. *A. Enslen*, w!).

Perennial, with short, thickened, sometimes creeping rhizome; stems to 1.5 m tall, pilose, scabrous, or almost glabrous; leaves lanceolate to elliptic, sessile, usually opposite, toothed or entire, upper surface scabrous, lower pilose, scabrous, or glabrous; heads several in close corymb; peduncles short, much branched, with or without glandular-pubescence; phyllaries lance-ovate to elliptic, imbricate, pilose, hispid, or rarely glabrous, with or without glandular-

pubescence; achenes obovate or orbicular-obovate, winged, toothed.

Pursh's description of *S. laevigatum* was based on plants collected by Aloysius Enslen in western Georgia. Pursh's description and the type specimen are very similar to *S. integrifolium*. If the specimen was collected in western Georgia, it was not within the present known range of *S. integrifolium*. Because the present range extends eastward to central Alabama, a few plants might have grown in western Georgia at an earlier time, or even at the present time, escaping collection for some reason. The possibility also exists that the information on Enslen's label is incorrect.

Silphium integrifolium is a rather homogeneous group of plants, morphologically. However, the most obvious and consistent differences are the kind and extent of vesture (vestiture) on the phyllaries and on the lower surface of the leaves.

KEY TO VARIETIES

A. Lower surface of leaves and phyllaries glabrous ..... 2. var. *gattingeri*
A. Lower surface of leaves and/or phyllaries pubescent ... B
  B. Lower surface of leaves pilose (velvety) ..... 3. var. *deamii*
  B. Lower surface of leaves hirsute, pubescent, or glabrous C
    C. Phyllaries glandular-pubescent ..... 4. var. *neglectum*
    C. Phyllaries not glandular-pubescent ..... 1. var. *integrifolium*

1. *Silphium integrifolium* Michx. var. *integrifolium*.

Although Perry (1937) mentioned "typical *S. integrifolium*," she naturally, at that time, did not refer to these plants as belonging to variety *integrifolium*. Cronquist (1945) called this group *S. integrifolium* var. *integrifolium*. C. A. Weatherby (1935, written communication to C. C.

Deam) examined the type sheet of *S. integrifolium* and found that the involucres are pustulate-scabrous or strigose, but not glandular.

2. *Silphium integrifolium* Michx. var. *gattingeri* Perry, Rhodora 39: 287, 288. 1937. (Holotype: Tennessee: Charlotte Pike, Nashville, July 1886, *Gattinger* GH!).

This variety has been found only in Davidson County, Tennessee.

3. *Silphium integrifolium* Michx. var. *deamii* Perry, Rhodora 39: 287. 1937. (Holotype: Indiana: Vermillion County, right of way of the railroad 1 mile east of Dana. *C. C. Deam* 54376 GH!).

Perry (1937) placed all of the plants of *S. integrifolium* having glandular-pubescent phyllaries into this variety.

4. *Silphium integrifolium* Michx. var. **neglectum** Settle and Fisher *var. nov.* (Holotype: Indiana: White County. *T. R. Fisher* 73, Bowling Green State University Herbarium!).

Phyllaria cum pilis glandulosis. Pagina inferior folii glabra vel pubescens sed non pilosa.

The plants of this variety have glandular-pubescent phyllaries and leaves with hirsute, pubescent, or glabrous, but not pilose, lower surface.

GEOGRAPHIC DISTRIBUTION

The general distribution of *Silphium integrifolium* is approximately the same as that of the tall grass prairie of the United States. The range of *S. integrifolium* extends into eastern Indiana, west into Kansas, southwest into Texas, southeast into Alabama, and north into Wisconsin. Distribution of the varieties, compiled from field collections and from herbarium specimens, is shown in Figure 3.

Silphium integrifolium and *S. speciosum* are sympatric in the Kansas-Oklahoma area, and *S. integrifolium* and *S. scaberrimum* are sympatric in the Oklahoma-Texas-Arkansas area. Naturally occurring putative hybrids between *S. integrifolium* and *S. speciosum* and between *S. integrifolium* and *S. scaberrimum* have been found.

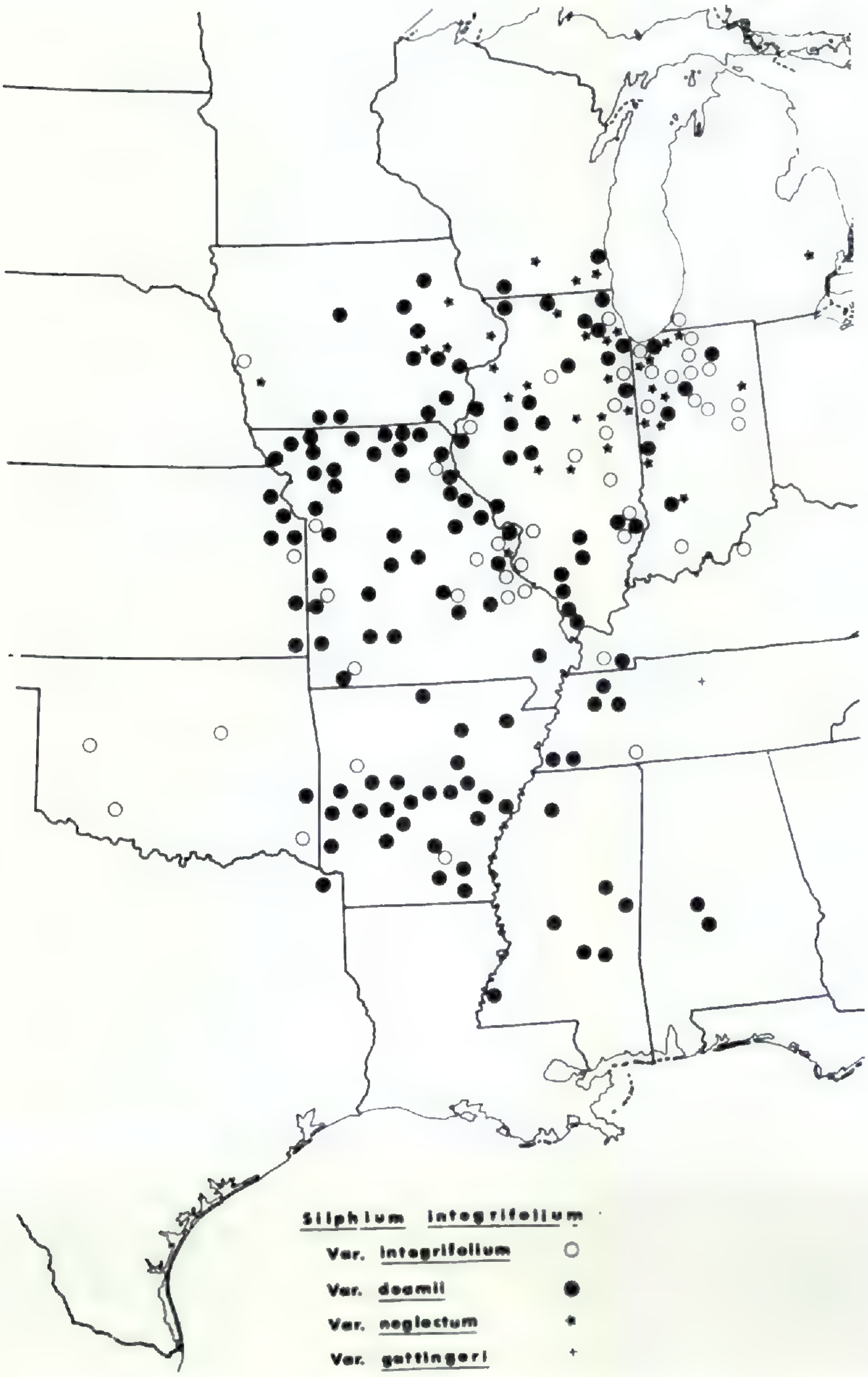

Figure 3. Distribution of *Silphium integrifolium* and its varieties.

The varieties (Figure 3) do not have distinct geographic distributions. The variety *neglectum* does have a restricted distribution, being restricted to the northeastern, glaciated portion of the range of the species. The variety *deamii* appears to be the most widespread geographically and also the most common of the varieties.

CONCLUSIONS

Three of the four varieties treated in this paper were recognized in Perry's work published in 1937. However, Perry's delimitation of varieties does not take into account a large portion of the plants which are distinctive because of the pilose pubescence of the lower surface of the leaves. This character is more striking and obvious than the glandular-pubescence of the phyllaries which Perry (1937) used as the principal basis for recognizing varieties.

The vesture of the abaxial surface of the leaves, in addition to the vesture of the phyllaries, seems to be a more satisfactory character upon which to base the varieties. Although *S. integrifolium* is a rather homogeneous group of plants, differences do exist which should be recognized. These differences are sufficient to merit recognition as separate varieties but not great enough to warrant separating the species into subspecies. Therefore, *S. integrifolium* should be considered to include four varieties: *S. integrifolium* var. *integrifolium*, *S. integrifolium* var. *deamii* Perry, *S. integrifolium* var. *gattingeri* Perry, and *S. integrifolium* var. *neglectum* Settle and Fisher.

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A PRIOR RECORD OF CHRYSANTHEMUM LACUSTRE BROTERO: In a recent note in this journal (72:250, 1970) I reported *Chrysanthemum lacustre* Brotero, a Portuguese introduction, as being recently discovered for the first time in Gray's Manual range. However, Camille Rousseau, of Université Laval in Quebec, has informed me of a record made twenty years previously in Canada. In Enumération des plantes du Canada, Naturaliste canadien, 93:1046 (1966) Bernard Boivin cites a collection from Ottawa, Ontario, deposited in the DAO Herbarium, with label reading "Abandoned fields, 1 mi. west of RR. bridge over Rideau Canal, 1948, G. A. Mulligan."

I am most appreciative of Prof. Rousseau's pointing out this earlier record and supplying me with the details.

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THE DISTRIBUTION OF PUBESCENT LEAVED INDIVIDUALS OF CONOCARPUS ERECTUS (COMBRETACEAE)

JOHN C. SEMPLE[1]

The buttonwood mangrove *Conocarpus erectus* L. grows along the coast of west tropical Africa, the Atlantic and Pacific coasts of tropical and subtropical North and South America and throughout the West Indies. Pubescent leaved individuals are restricted to the northern areas of the West Indies, southern Florida and northern Central America (Fig. 1) and have been variously named *C. pubescens* Schmach., *C. erectus* var. *sericeus* Fors. ex DC., *C. sericeus* (Fors. ex DC.) G. Don, *C. erectus* var. *sericeus* Griseb. and *C. sericeus* (Griseb.) Jimenez.

Stearn (1958) noted the existence of intermediate leaved individuals (*Stearn* 760 from Portland Ridge, Clarendon, Jamaica) and recommended that specific level be dropped in favor of varietal level. (In this article Stearn cited the type-locality of γ *sericeus* Griseb. as Antigua and St. Vincent, Lesser Antilles, but Grisebach (1860) listed *sericeus* only from the Bahamas (*Swain* α. γ), a locality consistent with the findings of this author).

Study of the variation in pubescence of material from F, GH, MO and fresh material in the field suggests division of the intermediate leaved condition into three groupings. The first condition consists of a few slightly pubescent leaves on an otherwise silky pubescent leaved plant. The converse of the first condition also occurs giving a plant with a few sparsely pubescent leaves on an otherwise glabrous leaved plant. The third condition consists of individuals with pubescent and glabrous leaves in a cyclic pattern.

---

[1]Supported by a NSF undergraduate grant, GY 5738 from Tufts University. Present address: Missouri Botanical Garden, St. Louis, Missouri 63110.

The advice of Dr. Norton H. Nickerson, Dr. Louis V. Wilcox, and Dr. Walter H. Lewis is gratefully acknowledged.

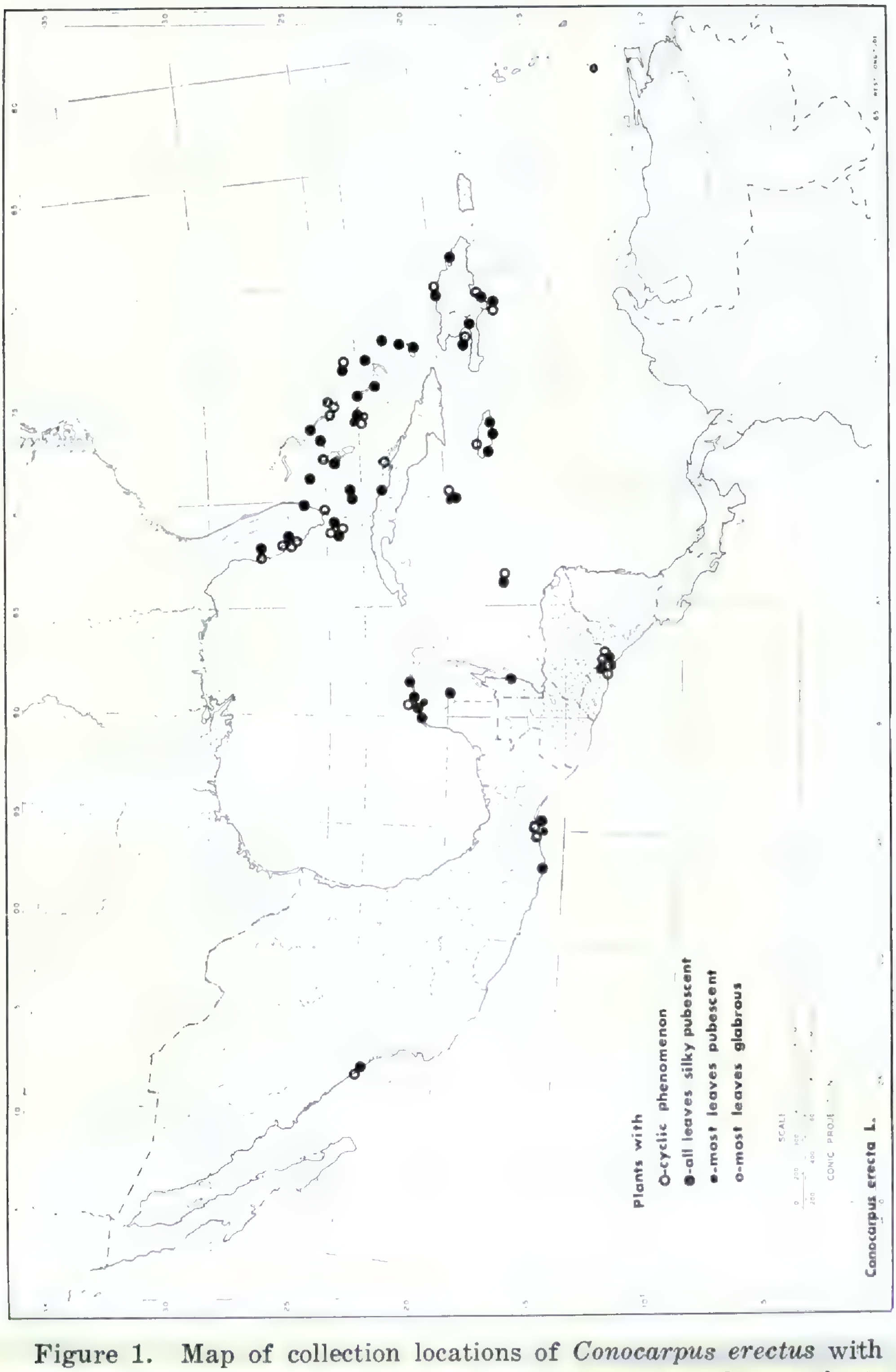

Figure 1. Map of collection locations of *Conocarpus erectus* with some leaf pubescence. See text for distribution of glabrous plants and the entire species.

In the complex phenomenon the degree of pubescence per leaf shifts from a high density of hairs to few or no hairs and back to the initial condition. The pattern of hair distribution on the leaves in the intermediate range of density is similar to the pattern of *Spiraea ulmaria* L. as described by Yapp (1912). The cycle may end with either pubescent leaves at the time of collection (*Elmore* D21 Chachua Bay, Oaxaca, Mex.) or with glabrous leaves at the time of collection (*Semple* 11, Duck Cay, Jewfish Chain, Great Exuma, Bahamas). Collection dates from various specimens indicate that the rate of cycling and the cycling itself are not necessarily seasonal. Cyclic flushing of pubescence has been noted in other species as well, for example, *Phragmites communis*, *Lysimachia vulgaris*, *Mentha aquatica*, *Pseudobarleria* sp. (all Yapp 1912), and *Populus alba* (H. Johnson, personal communication). The variation in leaf shape and degree of pubescence in *Borrichia arborescens* (L.) DC. show a similar phenomenon to that in *C. erectus*. The two can be found growing together in the Bahamas.

The distribution of the glabrous leaved form of *C. erectus* is equal to the full area of distribution of the species. Glabrous forms can be found growing with pubescent forms throughout the area indicated by Fig. 1. On various cays of Great Exuma, Bahamas, the two extremes may be found so close together that the roots and branches intermingle.

The existence of a full continum of intermediate forms between the glabrous and pubescent extremes even on the same branch dictates that varietal status for the extremes is unwarranted. The only name that can apply is *C. erectus* L. Future descriptions of the species should note that a wide range of leaf pubescence is possible for plants occurring in the northern areas of the species' distribution in the Americas.

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Correction in article on Rubus Hybrids.

On page 243, line 9, in this volume of Rhodora the name *Rubus frondosus* was erroneously given as being equivalent to the hybrid *R. Enslenii* × *pensilvanicus*. Actually this hybrid doesn't closely match any named blackberry of which we are aware. To conform with this correction the word most in the third line of page 242 should be changed to all. Thus the sentence as altered would read, "In the following treatment the names in parentheses that are given directly after some of the hybrid designations are binomials, in *all* cases rejected ones, which we consider to be equivalent to these hybrids."

F. L. Steele and A. R. Hodgdon

SALIX STARKEANA IN NORTH AMERICA

ALV DAN YOUNGBERG

The name *Salix depressa* L. subsp. *rostrata* (Anderss.) Hiitonen (Mem. Soc. Faun. Fl. Fennica 25: 82, 1950) has been applied to *Salix bebbiana* Sarg. in North America by Hultén (1968). However, *Salix depressa* L. and *Salix bebbiana* Sarg. are not closely related taxa. The epithet *depressa* has been the cause of some confusion among salicologists because several authors have used the same epithet for different species.

Salix depressa L. (Fl. Suec. 2nd ed: 352, 1755) is a synonym of *Salix lanata* L. (Sp. Pl. 1019, 1753). *Salix depressa* (non L.) as used in part by Fries (1832, 1840); Ledebour (1850); and Seemen (1909); is a synonym of *Salix starkeana* Willd., the European and Asian willow species most closely related to *Salix bebbiana* Sarg. of North America.

The epithet *rostrata* is also confusing because it has been applied to several different willow species. Richardson in 1823 used the epithet *rostrata* for a willow species he described from specimens collected somewhere in Canada west of Hudson Bay. However, he did not know that Thuiller had already used the epithet *rostrata* for a different taxon described by him in 1799. Sargent proposed *Salix bebbiana* as a new name for *Salix rostrata* Richardson in 1895.

Thus, we see that the taxonomy of Hiitonen and Hultén places the taxon known as *Salix bebbiana* Sarg. as a subspecies of the taxon known as *Salix lanata* L. These two willows have completely different morphological characters and have been placed in different sections by most European salicologists including Skvortsov of the U.S.S.R. (1968).

I consider *Salix bebbiana* to be a subspecies of *Salix starkeana* and propose the following taxonomy:

1. **Salix starkeana** Willd. subsp. **starkeana.**
   Salix starkeana Willd., Sp. Pl. 4(2): 677, 1806.

Salix livida Wahlenb., Fl. Lapp: 272, 1812.
Salix vagans Anderss., öfver. K. Vet. Akad. Förhand **15:** 121, 1858.
Salix depressa auct. (non L. 1755, Fl. Suec. 2 ed.: 332); Fries, 1832, Mantissa **1:** 56, id. 1840, Bot. Not.: 197; Ledb., 1850, Fl. Ross. 3, 2: 611; Seemen, 1909, in Aschers. et Graebn. Synops. 4: 115.
TYPUS: Silesia, prope Gurau, leg. *Starke* (B, K, LE, S).

2. **Salix starkeana** Willd., subsp. **bebbiana** (Sarg.) Youngberg, comb. nov.
Salix rostrata Richardson, in Franklin, Journey: 753, 1823; not Thuill., 1799.
Salix fusca Hooker, Fl. Bor.-Am. 2: 151, 1839; non L.
Salix vagans 1. *cinerascens* b. *occidentalis* Andersson, in öfv. Vet.-Akad. Förh. **15:** 122, 1858.
Salix vagans 1. *S. rostrata* Andersson, in Svensk. Vet.-Akad. Handl. **6:** 87, 1867.
Salix vagans occidentalis Andersson, in Svensk. Vet.-Akad. Handl. **6:** 87, 1867.
Salix livida occidentalis Gray, Man. ed 5, 464, 1867.
Salix vagans rostrata 3. *obovata* Andersson apud De Candolle, Prodr. **16**(2): 227, 1868.
Salix bebbiana Sarg., Gard. & Forest 8: 463, 1895.
Salix perrostrata Rydb., Bull. N.Y. Bot. Gard. 2: 163, 1901.
Salix depressa c. *rostrata* Seemen, in Ascherson & Graebner, Syn. Mitteleur. Fl. 4: 119, 1909.
Salix bebbiana var. *perrostrata* (Rydb) Schn., Jour. Arnold Arb. 2: 71, 1920.
TYPUS: Forest regions of Canada W. of Hudson Bay, *Richardson* (GH!, K, NY).

Salix bebbiana is very similar to *Salix starkeana*, but these two taxa may be distinguished by the following characters. The mature leaves and twigs of the current season usually have some hairs present in *Salix bebbiana* while

the mature leaves and twigs of the current season are glabrous in *Salix starkeana*. Subspecies *bebbiana* occurs in North America, and subspecies *starkeana* occurs in Finland, Czechoslovakia, Germany, Switzerland, Norway, Romania, Sweden, and the U.S.S.R.

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THE CHROMOSOME NUMBER OF OBOLARIA VIRGINICA L. (GENTIANACEAE)

KATSUHIKO KONDO

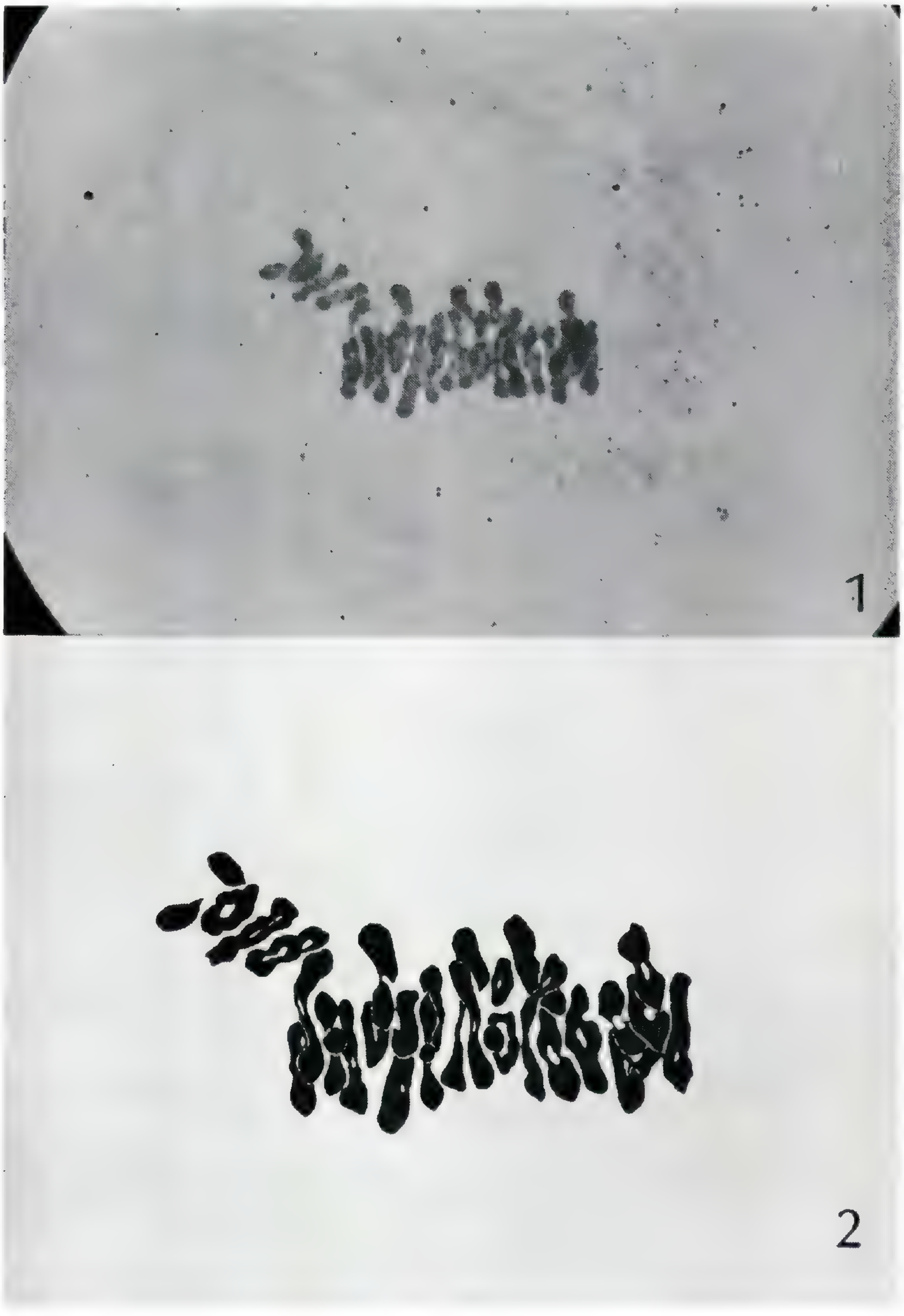
Investigations of chromosomes are necessary to the further classification and clarification of the natural relationships between species.

Obolaria virginica L. (Gentianaceae), which is monotypic, is common in rich mesic woods throughout the piedmont and mountain area in southeastern United States. The chromosome number of *O. virginica* (n=28) is here described for the first time.

O. virginica was collected on the campus of the University of North Carolina at Chapel Hill (coll. *K. Kondo* 562, March 10, 1970). The flower buds were fixed in Carnoy's solution: 6 : 3 : 1 of ethanol, chloroform and glacial acetic acid. Observations were made by the aceto-carmine squash method.

The meiotic divisions in the PMC's were very regular and 28 bivalent chromosomes at metaphase I of meiosis were clearly observed (Figs. 1 and 2). The bivalents were normal and consisted of two elements of equal size. Their forms were ring-shaped, conjugated at both ends, and stick-shaped, conjugated end to end. However, the author infers that the basic chromosome number of *Obolaria* is 7, and *O. virginica* is the octoploid which is constant.

Chromosome relationships of members of the Gentianaceae have been well studied by Rork (1949), Favarger (1952), and Wada (1955, 1956, and 1960). Members of the Gentianaceae show heteroploidy, and their basic chromosome numbers are 5, 6, 7, 8, 9, 11, and 13. The same basic chromosome number as *O. virginica* (X=7) occurs in several genera of this family, such as *Centaurium*, *Gentiana*, *Sabatia*, and *Swertia*. According to Rork's report (1949), about 58 per cent of the species of the Gentianaceae investigated to date are polyploid. Perennial species show no greater tendency toward polyploidy than do subperennial



Figs. 1 and 2. Chromosomes in pollen mother-cell of *Obolaria virginica* L. : $n=28$ (Fig. 1. × ca. 950; Fig. 2. × ca. 1450).

species; the subperennials have 32.8 per cent higher average chromosome number than the perennials.

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TRILLIUM CERNUUM L.
AND
GERANIUM MACULATUM L.:
NEW FOR SOUTH DAKOTA

Wild geranium (*Geranium maculatum* L.) and nodding wake robin (*Trillium cernuum* L.) are not listed for South Dakota by Over (1932) or Winter, Winter, and Van Bruggen (1959). *Geranium maculatum* (*Johnson* 73, NDA) and *Trillium cernuum Johnson* 69, NDA) were both collected on June 4, 1969, in Sieche Hollow State Park, 8 miles west and 6 miles north of Sisseton, South Dakota. Sieche Hollow is an erosional ravine located on the glacial landform called the Coteau des Prairies.

Both species were collected in dense, moist woods with an overstory consisting primarily of basswood *(Tilia americana)*, American elm *(Ulmus americana)*, sugar maple *(Acer saccharum)*, slippery elm *(Ulmus rubra)*, and ironwood *(Ostrya virginiana)*. Many species found here, including the above state records, are approximately fifty miles west of their known range in the deciduous forests of west-central Minnesota.

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A NEW MT. WASHINGTON STATION FOR GNAPHALIUM SUPINUM

Gnaphalium supinum L. is known in New England from Mt. Katahdin and Mt. Washington. It was first collected on Mt. Katahdin by Scribner in 1874 and has since been collected there several times probably from only two stations. Notations on the sheets indicate it is rare on this mountain.

On Mt. Washington it was first collected by William Boott in Tuckerman Ravine in 1855. Since then there have been a number of collections apparently confined to three or four stations. There appear to be two stations in Tuckerman Ravine and one or perhaps two high on the cone on the slope toward the Alpine Garden. I have explored the cone and Tuckerman Ravine rather thoroughly but have been able to locate only one of these stations. This is part way up the ravine and nearly in the middle of the trail. In the past several years I have not been able to find this colony. The trail receives heavy use and some erosion results along with trampling of vegetation. I think it likely that this station has been destroyed or at least reduced to a few isolated plants.

In view of the scarcity of this plant, I was most pleased, when last summer I came upon a colony of it in Huntington Ravine. This was a vigorous stand of one hundred or more plants growing in some gravel. It was far enough off the trail so that it was not in danger of trampling, but was not in a difficult place to reach. There are no records of it from Huntington Ravine in either the New England Botanical Club or the Gray Herbarium. As the Ravine has been rather thoroughly botanized in past years it is possible that this colony has developed rather recently. The windborn seeds presumably are readily transported over a considerable distance and could have arrived from the station on the cone. The plant seems to grow only on open gravelly sites of which there are rather few and another possibility is

that it could have seeded in from some small unbotanized location on the precipitous cliffs of the Ravine.

National Forest regulations forbid picking of plants in the alpine area so no collection was made. I did make careful notes of the colony for a record for my own herbarium and it is hoped that this note will serve as acceptable evidence of its occurrence in Huntington Ravine.

FREDERIC L. STEELE
ST. MARY'S-IN-THE-MOUNTAINS
LITTLETON, NEW HAMPSHIRE

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Errata for RHODORA

Page 6, lines 20 and 24, for microparpum read microcarpon.
Page 24, lines 2, 20, 29 and 36, for *angustata* read *angustatum*.
Page 147, line 36, for *Verononia* read *Vernonia*.
Page 150, line 37, for piedmont read Piedmont.
Page 154, line 36, for piedmont, coastal plain, read Piedmont, Coastal Plain.
Page 167, line 16, for arenchyma read aerenchyma.
Page 232, line 37, for *Rhycodrys* read *Phycodrys*.
Page 243, line 6, for York Co., read York Co., York.
Page 280, line 28, for *Tsua* read Tsuga.
Page 281, line 15, for *Hammamelis* read *Hamamelis*.

List of Sustaining members

Barneby, for Rubert read Rupert
Seymour, for Conklin read Conkling
Youngkin, for Herbert read Heber

Page 324, line 1, for spinescens read *spinescens*.
Page 325, line 58, for *umbiblicalis read umbilicalis*.
Page 338, line 10, for *tomentosus* read *tomentosum*.
Page 339, line 12, for *quinequefolia* read *nudicaulis*.
Page 340, line 14, for Hammelis read *Hamamelis*.
Page 344, line 14, for *orbiculata* read *orbiculatus*.
Page 346, line 29, insert) after islands.

Volume 72, No. 792 including pages 401-582, was issued December 31, 1970.

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